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CONTENTS OF No. 146.

	PAGE
Pleasant Hours with the Microscope. (*Illus.*) By Henry J. Slack, F.G.S., F.R.M.S.	125
The Capture Theory of Comets. By Richard A. Proctor	126
Chemistry of Cookery. XL. By W. M. Williams	128
Optical Recreations. (*Illus.*) By F.R.A.S.	129
The History of a Lightning Flash. By W. Slingo	131
The Earth's Shape and Motions. (*Illus.*) By Richard A. Proctor.	133
The Entomology of a Pond. (*Illus.*) By E. A. Butler	134
Zodiacal Maps. By R. A. Proctor	136
Other Worlds than Ours. By M. de Fontenelle. With Notes by Richard A. Proctor	136
Remarkable Storms in Belgium	138
International Health Exhibition. XII.	138
The Greely Expedition	140
Reviews	141
Editorial Gossip	141
The Face of the Sky. By F.R.A.S.	142
Miscellanea	143
Correspondence	143
Our Mathematical Column	145
Our Chess Column	146

PLEASANT HOURS WITH THE MICROSCOPE.

By HENRY J. SLACK, F.G.S., F.R.M.S.

THERE is a remarkable group of small insects interesting to the microscopist on account of their beauty and their strangeness, and interesting, also, in a bad sense, to the agriculturist and the gardener on account of their destructive habits. They belong to the Order Thysanoptera, or Fringe-wings, characterised by "four wings, alike, narrow, membranous, neither folded nor reticulated, with long ciliæ, laid horizontally along the back when at rest." Westwood, in his "Introduction to the Modern Classification of Insects," cites Haliday, the first important English observer,* and, in the main, agrees with his description of the mouth parts of these creatures, which, he says, "though constructed" in the mandibulated and palpigerous form, unite into a short conical sucker, which does not extend beyond the anterior coxæ." Curtis, in "Farm Insects," specially describes the species which injures corn (*T. cerealium*), and speaks of the trophi or mouth-parts uniting to form a short beak. Duncan, in his pretty book, "Transformations of Insects," founded upon Emile Blanchard, speaks of this species "*nibbling* the protecting envelopes of the grain"—a thing they could only do if they had mandibles constructed for biting, which is not the case. Westwood, although not detecting the principal feeding organ of these insects, judiciously said: "It appears doubtful whether the action, even of the maxillæ, can be transverse, or whether the insect can be said to bite its food."

The kind common in greenhouses is rather more than one-fifteenth of an inch long in its adult stage, exclusive of its antennæ. Its appearance, when considerably magnified, is shown in Fig. 1. To the naked eye, the full-grown specimen looks black, with white gauzy wings; but when mounted in Canada balsam, and seen with transmitted light, the colours are shades of brown, some much lighter than others, which may be a matter of age. Dark-ground illumination, and a magnification of about 50 linear, makes them objects of great beauty. Each segment of the little creature is decorated with an elegant network pattern. The antennæ are formed of segments like slender vases, the foot of one in the cup of another, and terminate like the top joints of a fishing-rod, the tip being exceedingly fine. Westwood says the number of joints varies from five to nine, in consequence of the terminal joints being more or less firmly soldered together. Fig. 5 shows the appearance of this organ highly magnified. The eyes are large and coarsely granulated, and there are ordinarily three ocelli.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

DESCRIPTION OF FIGURES. Fig. 5.

Fig. 1.—Greenhouse Thrip, highly magnified.
Fig. 2.—Rostrum. This is generally seen straight. The sketch is from one slightly curved, showing it is flexible.
Fig. 3.—Outline of maxillary palp.
Fig. 4.—Outline of labial palp.
Fig. 5.—Outline of antenna, drawn on a large scale, as a smaller one would not show the proportion the fine tip bears to the stouter parts.

Curtis says: "Every one must he acquainted with a little black insect, which alights on the face in hot weather, causing an intolerable irritation with its bladder-tipt feet, throwing up its head and twisting about its tail to expand or close its beautifully-fringed wings." The writer has not experienced this annoyance, which may be perpetrated by *T. cerealium*. The greenhouse sort, though common on

* "Entomological Magazine," Vols. III. and IV.

wild flowers as well as those of indoor growth, does not behave in that way. Most probably the mouths of all the species are constructed upon a closely similar pattern; but it is the greenhouse plague that is figured here. The mouth parts are very difficult to make a complete display of, but, capable of projection in advance of the "short-beak" of various writers, comes the long, flexible rostrum shown in Fig. 2. The writer thinks it is furnished with two or three very slender setæ, but leaves this for further inquiry. This organ, when at rest, lies in the middle of the "short beak," and unless projected forward is easily confounded with it. It seems capable of a lateral motion. All the mouth-organs commence at the lower part of the head. The "short beak" extends to the first coxæ, and the rostrum can be thrust beyond it. Fig. 3 is a maxillary palp, and Fig. 4 a labial one. Two slender "horny, setiform mandibles," as figured by Westwood, have sharp and probably piercing tips. In one mounted specimen two fine rapier-shaped instruments are thrust forward in advance of the rostrum, only the tip of which projects a little beyond the "short beak." Are they maxillæ? To see the rostrum, which has escaped the notice of so many observers, the head of the insect should be pushed off by pressing it *forwards* with a fine needle. This will probably cause the rostrum and some other parts to be seen extending *backwards*. If the first attempt is not successful, the process should be repeated till the end is accomplished. The larva and pupa much resemble the perfect insect, but they are yellow and very transparent. They reach the imago state through a succession of moultings. Their mouth organs seem like those of the adult, and if a few of the larger ones are mounted in thin Canada balsam some are pretty sure to exhibit the rostrum and some of the other mouth parts. In the head of the pupa several long muscular bands to work the mouth-parts are very interesting to view with powers of 200 and upwards. The mandibles and maxillæ are of transparent glassy aspect; the rostrum is brown and chitinous, deepening in tint towards the tip. When the whole of this organ is seen, it corresponds to a gun with the barrel at an angle with the much curved stock. Not having succeeded in displaying the whole of the mouth organs in their natural position, naming them is uncertain, except as regards the rostrum, which clearly belongs to the Haustellate or Sucking insects, and not to the Mandibulate or Biting ones.

Their modes of doing mischief are twofold. Firstly, by piercing leaves or other objects of attack, and sucking out the plant juices; and, in the second place, by depositing their excrement in the form of black globules as stiff as tar. Vines and fuchsias are favourite objects of attack. The adults seem to like the upper side of the leaves best, and the little yellow babies and juveniles affect the under side. The latter are so transparent as readily to show the contents of their intestines, and it is curious how soon their digestive processes turn the green leaf matter into the black mess which kills the part it is deposited upon. The insects may be seen moving about with balls of this stuff at the end of their tails. The adults, when disturbed at their work on the leaves, never use their wings in order to escape, but can run pretty quickly.

When they get into cucumber or melon frames they are very destructive, and troublesome to get rid of. They can stand a wonderful lot of tobacco-smoking, and most of the vaunted insecticides are of little use. With pot-plants, the best thing is to wash them off with yellow soap, or, better still, with Gishurst Compound, which is a sulphur soap.

The damage done by these little pests is always serious if they get into any frame or house, and the species that attacks farm crops is terribly injurious. Curtis quotes Halliday to the effect that in 1805 they destroyed one-third of the wheat crop in the richest part of Piedmont, and in the same year they caused similar losses to the British farmer. Olives, peaches, melons, and potatoes are assailed by some of the tribe. In attacking wheat, rye, &c., they are found between the interior valve of the corolla and the grain, causing the latter to shrink, or be *pungled*, as they call it in Suffolk. In one case an orange-coloured powder was noticed in the grains that had been attacked, and was taken for the insect's excrement, which is not at all like it. Probably the yellow powder was one of the rust fungi.*

In preparing these objects for the microscope some should be mounted whole in thin balsam. To display the wings, the abdomen should be pushed off, and the head, thorax, and wings treated in the same way. What to do with the head has already been explained. The feet do not exhibit the bladder-like endings at all well in balsam. Probably some fluid would do better, but they are very difficult to make out. Before balsaming the whole insect, it is well to soak it for an hour or two in a drop of carbolic acid, which helps to make the balsam penetrate, and adds to the transparency of the preparation.

THE CAPTURE THEORY OF COMETS.

By Richard A. Proctor.

(*Continued from page* 112.)

ARRIVED at Jupiter's distance from the sun, the meteor flight from interstellar space will have a velocity of about eleven miles per second. Now let us inquire what its velocity must be reduced to in order that it may thenceforth be compelled to travel in a circle around the sun. As a matter of fact, all the members of Jupiter's comet-family travel in orbits whose remotest parts are near Jupiter's orbit, and to give a comet such an orbit as one of these much more must be done in the way of reducing velocity than is necessary merely to make the meteor flight from outer space travel thenceforth in a circle at Jupiter's mean distance. We are taking, in fact, a very unfavourable case for our argument. Still, the velocity must be reduced, even in this case, by nearly three-tenths, or by more than three miles per second.

Now Jupiter's power to withdraw velocity from a body in his neighbourhood is measured by his power to impart velocity. In fact, both processes are but different forms of the same kind of work. Precisely as we say that the sun can communicate a velocity of three hundred and eighty-two miles per second to a body approaching him from interstellar distances, and that therefore the sun can withdraw such velocity from a body leaving his surface at that rate, and eventually bring such a body to rest out yonder in interstellar space, so can we make a corresponding statement for any planet,—Jupiter or Saturn, the Earth, our Moon, and even for the least of all, the asteroidal family (supposing only the mass and size known). In the case of Jupiter, for instance, we find that the utmost velocity he can impart to a body reaching him from external space is about thirty-six miles per second. That, at least, is the velocity with which such a body would reach the visible surface of the planet. What the velocity might be with which the real surface, far down below the visible envelope of clouds, would be reached, we do not know,—not knowing where that surface lies. In the case of our own earth, the

* Dr. Cooke's "Microscopic Fungi" is a good popular introduction to the study of rust, smut, &c.

velocity with which a body would reach the surface, if brought thither solely by the earth's action from interstellar space, would be a little over seven miles per second, or more than twenty-seven times greater than the velocity of the swiftest cannon-ball.

But while Jupiter—to keep for the moment to our giant planet—has thus, theoretically, the power of giving or taking away a velocity of thirty-six miles per second, he is not practically able to do anything of the sort. He is not left to draw matter to himself, or to act on the recession of matter from himself, alone. The bodies which come near to him from outer space have been drawn by solar might within that distance from the sun, and almost the whole velocity they there possess is sun-imparted. We have seen what it is—some eleven miles per second. Now manifestly this greatly affects Jupiter's power of imparting or withdrawing velocity. Both processes require time, and it is clearly impossible for Jupiter to produce anything like the same effect on a body rushing past him with a sun-imparted velocity of eleven miles per second as he would produce on a body left undisturbed to his own attraction. Jupiter's action at any moment is the same whether the body is moving or at rest; but the number of movements is very much reduced owing to the swift rush of the body past the planet. To use the old-fashioned expression of the first students of gravitation (an expression which has always seemed to me amusingly quaint) the solicitations of Jupiter's attractive force are as urgent on a swiftly rushing body as on one at rest; but if a body will not stay to hearken to them, much less effect must be produced. In all this part of my reasoning, I may remark, I am not pleading a cause, but indicating what every student of celestial dynamics knows.

We may fairly regard twenty-five miles per second as the utmost velocity that Jupiter can impart or take from any body coming out of interplanetary space past him, as close as such a body can pass without being actually captured. Moreover, in every possible case, Jupiter can only abstract or add a small portion of this amount; for this reason, simply, that in every possible case there will be first an action of one kind (abstraction or addition of velocity), and afterward an action of the opposite kind (addition or abstraction respectively). It will be but the difference between these effects, in most cases very nearly equal, which will actually tell on the body's future period of revolution around the sun.* This makes an enormous reduction on Jupiter's potency to modify cometic revolution. Certainly ten miles per second is a very full estimate of the velocity he can abstract or add in the case of a body passing quite close to his apparent surface.

But even this may seem ample. Seeing that a loss of three miles or so per second would cause a body which had reached Jupiter's distance from the sun, after a journey from out of interplanetary space, to travel in the same period around the sun as Jupiter himself, and since we seem to recognise a power in Jupiter to abstract ten miles per second, it would seem as though Jupiter's capturing power were in fact demonstrated.

But while, to begin with, the close approach required for this capturing power to exist is something very different from that approach within a million miles which I before considered, there is a much more important difficulty to be considered, in the circumstance that we have thus far dealt with Jupiter's capturing power on one body, not on a flight of bodies, such as a comet approaching from interstellar space is held to be, according to the theory I am discussing. Let us take the former point, though the least important, first.

At Jupiter's apparent surface the actual maximum velocity which the planet could give to a body approaching from a practically infinite distance would be about thirty-six miles per second, and we reduced the actual maximum effect on a body passing Jupiter very close, under such conditions as actually prevail in the solar system, to ten miles per second. Let us see what would be the corresponding numbers in the case of a body passing within a million miles of him, remembering that even that would carry such a body right through Jupiter's system of satellites, the span of that system being about four and a half millions of miles. Since a distance of one million miles exceeds the distance of Jupiter's surface from his centre nearly twenty-five times, it follows (I need not explain why; mathematicians will know, and for non-mathematicians the explanations would be tedious and difficult) that the velocities which Jupiter can give or abstract at the greater distance would all be reduced to little more than one-fifth those determined for Jupiter's surface. So, instead of ten miles per second, we should get but two miles per second, as the greatest Jupiter could abstract from a body approaching him within a million miles. And this would not be sufficient reduction to make such a body travel thenceforth in Jupiter's period, still less in one of the much shorter periods observed throughout what has been called Jupiter's comet-family.

But the other difficulty is altogether more serious. A comet approaches Jupiter, on the theory we are dealing with,—and indeed the same may be assumed on any theory,—as a flight of scattered bodies. Either this flight is so close as to be in effect, because of mutual attractions, a single body, or it is not. If it is, the flight will not be broken up by Jupiter's action; and, if not so broken up, will remain for ever after a united family. But if, as is more in accordance with observed facts, the cometic flight is so large that the attraction of the flight, as a whole, on the separate members, can be overcome by Jupiter's action, then not only will the flight be broken up, but the orbits given to different members of it by Jupiter's disturbing action will be widely different. Suppose, for example, the extent of the flight to be such that the parts coming nearest to Jupiter approach his centre within fifty thousand miles (a very close approach, indeed, to his surface), while those parts which are remotest from him at the time when the flight, as a whole, is nearest, came only within sixty thousand miles from his centre. Then, in round figures, the reduction of velocity of the nearer members of the flight will be greater than the reduction for the farther members, as six exceeds five. Supposing, for argument's sake, the former reduction to be three miles per second, as it must be to make those members of the flight travel thenceforth in Jupiter's period round the sun, then the reduction for the outermost members would be but three and a half miles per second; or thenceforth one set of meteors formerly belonging to the comet would have at Jupiter's distance a velocity of eight miles per second (eleven less three), while another set would have a velocity of eight and a half miles per second (eleven less two and a half) at that distance. This means that thenceforth the mean distance of the latter set from the sun would exceed the mean distance of the former set about as nine exceeds eight.* Since the former set would thenceforth be

* As distinguished from the orbit. The orbit might be largely affected even in a case where the velocity at Jupiter's distance remained absolutely unchanged; but in this case the period of revolution would remain the same.

* The simple law is, that for two bodies having different velocities at the same distance from the sun, the mean distances from him differ as the square of those velocities. Now, the square of eight and a half is seventy-two and a quarter; that of eight is sixty-four.

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travelling at Jupiter's distance, or about 5·2 times the earth's, the latter set would be travelling at a mean distance greater by one-eighth of this, or ·65 of the earth's distance, say some sixty millions of miles. The latter set would be at their nearest to the sun when at Jupiter's distance, would pass sixty millions of miles farther away to their mean distance, and as much farther away still at their greatest distance. Practically, then, even in this case, as favourable for capture as can be well imagined, the capture, though effected, would result in spreading out the comet, which had arrived as a compact flight of meteors ten thousand miles only in span, over a region one hundred and twenty millions of miles broad. It is hardly necessary to say that nothing like this is observed in the case of any member of Jupiter's comet-family. We know that along their track meteors are strewn to distances which, in some cases, may well exceed even the enormous distance just named; but they lie along the track, not ranging more than a few hundred thousand miles on either side from the path of the comet's head. This means that the orbit of every single meteor of such a system has, practically, the same mean distance from the sun.

The difficulty last considered is simply fatal to the theory that the comets forming what have been called the comet-families of the giant planets were captured by those orbs in the way imagined by Heis, Schiaparelli, and others.

THE CHEMISTRY OF COOKERY.

By W. Mattieu Williams.

XL.—COUNT RUMFORD'S SUBSTITUTE FOR TEA.

TAKE eight parts by weight (say ounces) of meal (Rumford says "wheat or rye-meal," and I add, or oatmeal), and one part of butter. Melt the butter in a clean *iron* frying-pan, and when thus melted sprinkle the meal into it; stir the whole briskly with a broad wooden spoon or spatula till the butter has disappeared and the meal is of an uniform brown colour like roasted coffee, great care being taken to prevent burning on the bottom of the pan. About half an ounce of this roasted meal boiled in a pint of water, and seasoned with salt, pepper, and vinegar, forms "burnt soup," much used by the wood-cutters of Bavaria, who work in the mountains far away from any habitations. Their provisions for a week (the time they commonly remain in the mountains) consist of a large loaf of rye bread (which, as it does not so soon grow dry and stale as wheaten bread is always preferred to it); a linen bag, containing a small quantity of roasted meal, prepared as above; another small bag of salt, and a small wooden box containing some pounded black pepper; and sometimes, but not often, a small bottle of vinegar; but *black pepper* is an ingredient never omitted. The rye bread, which eaten alone or with cold water would be very hard fare, is rendered palatable and satisfactory, Rumford thinks also more wholesome and nutritious, by the help of a bowl of hot soup, so easily prepared from the roasted meal. He tells us that this is not only used by the wood-cutters, but that it is also the common breakfast of the Bavarian peasant, and adds that "it is infinitely preferable, in all respects, to that most pernicious wash, *tea*, with which the lower classes of the inhabitants of this island drench their stomachs and ruin their constitutions." He adds that, "when tea is taken with a sufficient quantity of sugar and good cream, and with a large quantity of bread-and-butter, or with toast and boiled eggs, and, above all, *when it is not drank too hot*, it is certainly less unwholesome; but a simple infusion of this drug, drank boiling hot, as the poor usually take it, is certainly a poison, which, though it is sometimes slow in its operation, never fails to produce fatal effects, even in the strongest constitutions, where the free use of it is continued for a considerable length of time.'"

This may appear to many a very strong condemnation of their favourite beverage; nevertheless, I am satisfied that it is perfectly sound. This is not an opinion hastily adopted, but a conclusion based upon many observations, extending over a long period of years, and confirmed by experiments made upon myself.

The *Pall Mall Gazette* of Aug. 7 says:—"There is balm for tea-drinkers in one of Mr. Mattieu Williams's 'Science Notes' in the *Gentleman's Magazine*." This is true to a certain extent. I referred to the Chinese as habitual drinkers of boiled water, and suggest that this may explain their comparative immunity from cholera, where all the other conditions for a raging epidemic are fulfilled. It is the boiling of the water, not the infusion of tea-leaves therein, to which I attribute the destruction of the germs of infection.

In the note which follows, I proposed an infusion of fried or toasted bread-crumbs, oatmeal, maize, wheat, barley, malt, &c., as a substitute for the tea, the deep colour of the infusion (poured off from the grounds in this case) serving to certify the boiling of the water. Rumford's burnt soup, taken habitually at breakfast or other meals, would answer the same purpose, with the further advantage to poor people of being, to a certain extent, a nutritious soup as well as a beverage. All that is nutritous in porter is in this, minus the alcoholic drug and its vile companion, the fusel oil.

The experience of every confirmed tea-drinker, when soundly interpreted, supplies condemnation of the beverage; the plea commonly and blindly urged on its behalf being, when understood, an eloquent expression of such condemnation. "It is so refreshing"; "I am fit for nothing when tea-time comes round until I have had my tea, and then I am fit for anything." The "fit for nothing" state comes on at five p.m., when the drug is taken at the orthodox time, or even in the early morning, in the case of those who are accustomed to have a cup of tea brought to their bedside before rising. With blindness still more profound, some will plead for tea by telling that by its aid one can sit up all night long at brain-work without feeling sleepy, provided ample supplies of the infusion are taken from time to time.

It is unquestionably true that such may be done; that the tea-drinker is languid and weary at tea-time, whatever be the hour, and that the refreshment produced by "the cup that cheers" and is *said* not to inebriate, is almost instantaneous.

What is the true significance of these facts?

The refreshment is certainly not due to nutrition, not to the rebuilding of any worn-out or exhausted organic tissue. The total quantity of material conveyed from the tea-leaves into the water is ridiculously too small for the performance of any such nutritive function; and besides this, the action is far too rapid, there is not sufficient time for the conversion of even that minute quantity into organised working tissue. The action cannot be that of a food, but is purely and simply that of a stimulating or irritant drug, acting directly and abnormally on the nervous system.

The five o'clock lassitude and craving is neither more nor less than the reaction induced by the habitual abnormal stimulation; or otherwise, and quite fairly, stated, it is the outward symptom of a diseased condition of brain produced by the action of a drug; it may be but a mild form of disease, but it is truly a disease nevertheless.

The active principle which produces this result is the

crystalline alkaloid, the *theine*, a compound belonging to the same class as strychnine and a number of similar vegetable poisons. These, when diluted, act medicinally, that is, produce disturbance of normal functions as the tea does, and, like theine, most of them act specially on the nervous system; when concentrated they are dreadful poisons, very small doses producing death.

The non-tea-drinker does not suffer any of these five o'clock symptoms, and, if otherwise in sound health, remains in steady working condition until his day's work is ended and the time for rest and sleep arrives. But the habitual victim of any kind of drug or disturber of normal functions acquires a diseased condition, displayed by the loss of vitality or other deviation from normal condition, which is temporarily relieved by the usual dose of the drug, but only in such wise as to generate a renewed craving. I include in this general statement all the vice-drugs (to coin a general name), such as alcohol, opium, tobacco (whether smoked, chewed, or snuffed), arsenic, haschisch, betel-nut, coca-leef, thorn-apple, Siberian fungus, maté, &c., all of which are excessively "refreshing" to their victims, and of which the use may be, and has been, defended by the same arguments as those used by the advocates of habitual tea-drinking.

Speaking generally, the reaction or residual effect of these on the system is nearly the opposite of that of their immediate effect, and thus larger and larger doses are demanded to bring the system to its normal condition. The non-tea-drinker or moderate drinker is kept awake by a cup of tea or coffee taken late at night, while the hard drinker of these beverages scarcely feels any effect, especially if accustomed to take it at that time.

The practice of taking tea or coffee by students, in order to work at night, is downright madness, especially when preparing for an examination. More than half of the cases of break-down, loss of memory, fainting, &c., which occur during severe examinations, and far more frequently than is commonly known, are due to this.

I frequently hear of promising students who have thus failed; and, on inquiry, have learned—in almost every instance—that the victim has previously drugged himself with tea or coffee. Sleep is the rest of the brain; to rob the hard-worked brain of its necessary rest is cerebral suicide.

My old friend, the late Thomas Wright, was a victim of this terrible folly. He undertook the translation of the "Life of Julius Cæsar," by Napoleon III., and to do it in a cruelly short time. He fulfilled his contract by sitting up several nights successively by the aid of strong tea or coffee (I forget which). I saw him shortly afterwards. In a few weeks he had aged alarmingly, had become quite bald, his brain gave way and never recovered. There was but little difference between his age and mine, and but for this dreadful cerebral strain, rendered possible only by the alkaloid (for otherwise he would have fallen to sleep over his work, and thereby saved his life) he might still be amusing and instructing thousands of readers by fresh volumes of popularised archæological research.

I need scarcely add that all I have said above applies to coffee as to tea, though not so seriously *in this country*. The active alkaloid is the same in both, but tea contains weight for weight about three times as much as coffee. In this country we commonly use about 50 per cent. more coffee than tea to each given measure of water, and thus get about half as much alkaloid. On the continent they use about double our quantity (this is the true secret of "Coffee as in France"), and thus produce as potent an infusion as our tea.

I need scarcely add that the above remarks are exclusively applied to the *habitual* use of these stimulants. As medicines, used occasionally and judiciously, they are invaluable, provided always that they are not used as ordinary beverages. In Italy, Greece, and some parts of the East it is customary when anybody feels ill with indefinite symptoms to send to the druggist for a dose of tea. From what I have seen of its action on non-tea-drinkers it appears to be specially potent in arresting the premonitory symptoms of fever, the fever headache, &c.

OPTICAL RECREATIONS.

By a Fellow of the Royal Astronomical Society.

(*Continued from page* 47.)

We may fitly conclude our few remarks upon lenses by a description of the methods adopted to find their foci, which the amateur will often find very useful. First, in the case of a convex lens of any considerable size, a cardboard disc may be fitted at the end of a straightedge accurately graduated into feet, inches, and tenths of an inch, at right angles to its length. This arrangement is then taken out into the sunshine, and the lens whose focal length is to be measured is slid along the straightedge rigidly parallel to the screen, until a sharp and distinct image of the sun is formed upon the latter. The distance between the point where the middle of the edge of the lens rests on the straightedge and the screen may then be taken off the scale by mere inspection. Or, suppose that we wish to find the focus of our lens when sunlight is not available. We place a lighted candle at the end of a graduated scale of inches and parts, and so connect the lens with the scale that it may always have its axis parallel with the edge of the scale as it slides along it. A card disc, or screen, must also be made to slide along the scale so as to be in a line with the light and the lens, the light being manifestly on one side of the lens and the card on the other. Both the lens and the card must now be shifted backwards and forwards until the *least* distance between the light and the card is found, at which a sharp image of the candle is depicted on the latter. Then, if we measure this least distance accurately, it is four times the focal length of the lens. An ingenious modification of this method devised by the Rev. Prebendary Webb, and applicable to the measurement of the foci of the smallest lenses, is illustrated in Fig. 22, in which K N is a

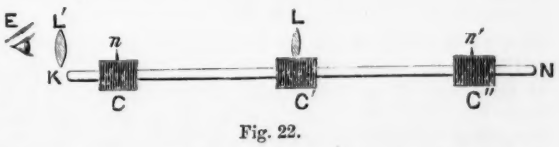


Fig. 22.

knitting-needle, along which three perforated corks, C, C′, C″, slide. To the one in the middle, C′, the lens, L, whose focus is to be measured, is attached in a vertical position, with its axis parallel to K N; while in each of the two others is stuck a piece of an ordinary sewing-needle, n, n', point uppermost, and of such a length that a line joining the two points p shall pass, as nearly as can be managed, through the centre of the lens, L. Now, as in our previous experiment, the corks are moved backwards and forwards until the inverted image of the needle-point, n', formed by the lens is seen coincident, and equally distinct, with the point of the needle, n, when both are viewed through a pretty strong magnifier, L′, by the eye at E. If this condition of things obtains when the needle-points are

sensibly equidistant on each side of the lens (and we must shift them about until they are), then, if we take the distance between them very accurately—preferably with compasses and a finely-divided scale—this, as before, will be four times the focal length of the lens for parallel rays. And while on the subject of the measurement of the focus of lenses, we may just mention a simple way in which that of an equi-concave lens may be ascertained; a kind of determination which sometimes puzzles the beginner. Blacken one side of the lens whose focus you wish to find, and draw a diametrical line across the black backing. On this line make two dots, about the twentieth of an inch in diameter, and equidistant from the centre (or, what is of course the same thing, from the edges) of the lens. Now, hold your lens square to the Sun's rays with its unblacked face turned towards him, and place a card screen, as nearly parallel as may be to the face of the lens to receive the resulting image. Measure very carefully the distance apart of the spots on your lens, and shift the screen about until their images are exactly *twice* this distance apart; then will the distance between the screen and the lens be the virtual focus of the latter.

While we are on the subject of measurement, and before proceeding to the consideration of the structure of the human eye, and of the phenomena of vision, we may say something on the very interesting subject of photometry, or the measurement of the relative amounts of light emitted by various sources of it. We see lamps advertised which are guaranteed to give the light of sixteen or twenty candles, as the case may be. How can we find out for ourselves whether this quantity of light really is emitted by any given flame or not? The principle on which this is done will be apparent from Fig. 23,

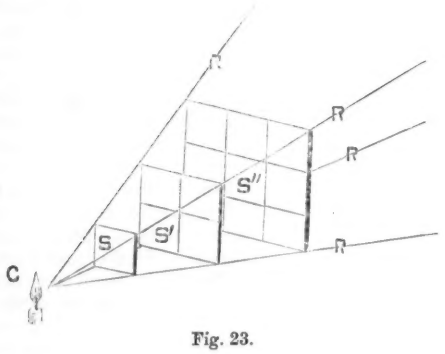


Fig. 23.

wherein C is the flame of a candle, from which rays CR, CR^1, &c., are radiating. If now we place a piece of cardboard, S, one foot square, at S, a distance of 2 ft. from the candle, C, a glance at our figure will show that its shadow will just cover an area of four square feet (*i.e.* two feet high and two feet wide), and so on. Or, putting it in another way, if we removed the first screen, S, altogether, the light falling on an equal area of another screen, S′, at twice the distance would only be one-quarter as intense as that lighting the nearer screen. At three times the distance, S″, the candle would only give one-ninth of the light it does at distance unity; upon an equal area four times as far off, one-sixteenth, and so on. And this we may express in the form of the following law: the intensity of light is inversely proportional to the square of the distance of the illuminated surface from the source of it. Hence a very little thought will show that when two sources of light produce equal intensities of illumination at different distances, their illuminating powers must be in the ratio of the squares of their distances from the illuminated surface. This supplies us with a ready means of measuring the intensity of any given light. For we may adopt Rumford's method, illustrated in Fig. 24.

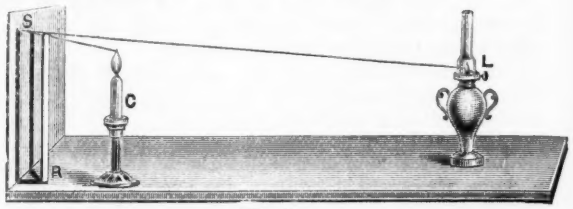


Fig. 24.

In this figure S represents a white card screen, in front of which stands a rod about as thick as an ordinary drawing pencil. It will be seen that each of the two lights to be compared casts a shadow of the rod, and each light illuminates the shadow cast by the other. Let us suppose now that our candle, C, is one foot from the screen; then if, on moving the lamp, L, to a distance of four feet from the screen, the two shadows appear identical in depth, the lamp really must give sixteen times the light of the candle. It will be quite evident that had it given a precisely similar shadow to that caused by the candle when removed to a distance of five feet, it must have emitted light of twenty-five-candle power, and so on. Bunsen's photometer is, if possible, more simple still in construction, consisting, as it does, mainly of a sheet of white paper with a grease spot on it. This, of course, lets more light through it than the rest of the paper. Hence, if it be illuminated more strongly from behind, it will appear to be bright on a dark ground. If the front surface be the more strongly lighted, it will seem to be dark upon a light ground; while, if absolutely equally illuminated on both sides, it will disappear as a spot, and be merged in the general surface of the paper. In employing this simple device a sheet of white paper should be stretched on a frame, and the lights, whose relative intensity is to be measured, placed one on each side of it at the height of the spot; then they are moved about until the spot disappears, and, such disappearance being complete, the distances of the lights are measured from the screen, the squaring of those distances as before giving the comparative intensities of the lights. One practical word of caution is needed here as to the method of making the grease-spot, as oil would create one of which it would be very difficult to cause the disappearance. The best plan is to let a drop or two of stearine fall on to the paper from a burning candle, and when it has cooled scrape the superfluous stearine off the paper with a pen-knife. Then the stearined spot should be placed in a fold or two of blotting-paper, and ironed with a hot iron until it becomes of the proper strength. This the reader must ascertain for himself by direct experiment. The two common forms of photometer which we have just described will amply serve to illustrate the principle on which such measurements are made, and will afford the student both amusement and instruction. Into the great subject of celestial photometry we cannot here enter, our object being, as we have before stated, to describe optical experiments which can be performed without the aid of any elaborate or costly apparatus, and with materials within the reach of everybody.

The *Medical Press and Circular* says:—One of the effects of the cholera scare is the sudden increase in market prices of all kinds of disinfectants. Opium, too, has gone up twenty-five per cent., and sulphate of morphine has likewise advanced. We hear that the demand is so great from France that one well-known English house cannot manufacture carbolic acid sufficiently fast to meet it.

THE HISTORY OF A LIGHTNING FLASH.

By W. Slingo.

LATELY we have all felt, I doubt not, a considerable amount of interest in the various phenomena attending this summer's unusually heavy thunderstorms, accompanied, as they have been, by vivid lightning discharges of a more or less hurtful nature. The list of disasters published in Knowledge, No. 143, might be very materially augmented were we to record such damage as has been wrought since that list was compiled.

There is not, I suppose, in the mind of any intelligent man at the present day a doubt as to the electrical origin of a lightning flash. The questions to be considered are rather whence comes the electricity? and in what way is the thunderstorm brought about? In attempting to answer these questions, sight must not be lost of the fact that the very nature of electricity is in itself almost sufficient to baffle any effort put forth to ascertain from lightning, as such, its whence and its whither.

It is possible, however, with the aid of our knowledge of static electricity, to arrive at hypotheses of a more than chimerical nature. In the first place, that our sphere is a more or less electrified body is generally admitted. More than this, it is demonstrated that the different parts of the earth's surface and its enveloping atmosphere are variously charged. As a consequence of these varying charges, there is a constant series of currents flowing through the various parts of the earth, which show themselves in such telegraph-wires as may lie in the direction followed by the currents. Such currents are known as earth-currents, and present phenomena of a highly interesting nature. But, apart from these electrical manifestations, there is generally a difference of electrical condition between the various parts of the earth's surface and those portions of the atmosphere adjacent to or above them. Inasmuch as air is one of the very best insulators, this difference of condition (or potential) in any particular region is in most cases incapable of being neutralised or equilibriated by an electric flow. Consequently the air remains more or less continually charged. With these points admitted as facts, the question arises, Whence this electricity? There have been very many and various opinions expressed as to the cause of terrestrial electricity, but far the greater portions of such theories lack fundamental probability, and indicate causes which cannot be regarded as sufficiently extensive or operative to produce such tremendous effects as are occasionally witnessed. I take it that we may safely regard the evolution of electricity as one of the ways in which force exhibits itself, that, in other words, when work is performed electricity may result. When two bodies are rubbed together, electricity is produced, so also is it when two connected metals are immersed in water and one of them is dissolved, or when one of the junctions of two metals is raised to a higher temperature than the other junction. I will go further than this, so far, in fact, as to maintain that there is reasonable ground for supposing that every movement, whether it be of the mass or amongst the constituent particles, is attended by a change of electrical distribution, and if this is true it may easily be conceived that inasmuch as motion is the rule of the universe, there must be a constant series of electrical changes. Now, these changes do not all operate in one direction, nor are they all of similar character, whence it is that not only are there earth currents of feeble electro-motive force, but that this E M F is constantly varying, and that, furthermore, electricity of high E M F is to be met with in various parts of the atmosphere.

With earth currents we have here very little to do. The rotation of the earth is in itself sufficient to generate small currents, and the fact that they vary in strength at regular periods of the day and of the year enforces the suggestion that the sun exerts considerable electrical influence on the earth. Letting it be granted, however, that the earth is variously charged, how comes it that the air is also charged, and with electricity of greater tension than that of the earth itself? It was pointed out by Sir W. Grove that if the extremities of a piece of platinum wire be placed in a candle-flame, one at the bottom and the other near the top, an electric current will flow through the wire, indicating the presence of electricity. If an electrified body be heated, the electricity escapes more rapidly as the temperature rises. If a vessel of water be electrified, and the water then converted into steam, the electric charge will be rapidly dissipated. If a vessel containing water be electrified, and the water allowed to escape drop by drop, electricity will escape with each drop, and the vessel will soon be discharged. We regard it as an established fact that the earth has always a greater or less charge; whence it is safe to assume that in the process of evaporation which is going on all over the surface of the globe, more particularly in equatorial regions, every particle of water, as it rises into the air, carries with it its portion, however minute that portion may be, of the earth's electric charge. This small charge distributes itself over the surface of the aqueous particle, and the vapour rises higher and higher until it reaches that point above which the air is too rare to support it. It then flows away laterally, and as it approaches colder regions, gets denser, sinking lower and nearer to the earth's surface. The aqueous particles becoming reduced in size, the extent of their surfaces is proportionately reduced. It follows that as the particles and their surfaces are reduced, the charge is confined to a smaller surface, and attains, therefore, a greater "surface density," or, in simpler language, a greater amount of electricity per unit of surface. Electricity, as above set forth, is in what is known as the "static" condition (to distinguish it from electricity which is being transferred in the form of a current), when it has the property of "repelling itself" to the utmost limits of any conductor upon which it may be confined. This will account for the charge finding its way to the surface of the water particles, and will furthermore account for the greater density of the charge as the particle gets smaller and has the extent of its surface rapidly diminished. It may be mentioned that the surface of a sphere varies as the cube of its radius. Returning to the discussion of the state of affairs existing when the particles have reached their highest position in the atmosphere, we may imagine that they set themselves off on journeys towards either the north or the south pole. As they pass from the hotter to the colder regions, a number of particles coalesce; these again combine with others on the road until the vapour becomes visible as cloud. The increased density implies increased weight, and the cloud particles, as they sail pole-wards, descend towards the surface of the earth. Assuming that a spherical form is maintained throughout, the condensation of a number of particles implies a considerable reduction of surface. Thus, the contents of two spheres vary as the cubes of their radii, or eight (the cube of 2) drops on combining will form a drop twice the radius of one of the original drops. We may safely conceive hundreds and thousands of such combinations to take place until a cloud mass is formed, in which the constituent parts are more or less in contact, and, therefore, behave electrically as a single conductor of

irregular surface, upon which is accumulated all the electricity that was previously distributed over the surfaces of the millions of particles that now compose it.

The tendency of an electric charge upon the surface of a conductor is to take upon itself a position in which it may approach nearest to an equal and opposite charge, or, if possible, to attain neutrality. If, then, a cloud has a charge, and there is no other cloud above or near it, the charge *induces* on the adjacent earth surface, electricity of the opposite kind. Thus, assuming the cloud to be charged with positive electricity, the subjacent earth will be in the negative state. The two electricities* exert a strong tendency to combine or to produce neutrality, whence there is a species of stress applied to the intervening air. Possibly the cloud will be drawn bodily towards the earth more or less rapidly, according as the charge is great or small. Or, on the other hand, the cloud may roll on for leagues, carrying its influence with it, so that the various portions of the earth underneath become successively charged and discharged as the cloud progresses on its journey.

Should the cloud be near the earth, or should it be very highly charged, the tension of the two electricities may be so great as to overcome the resistance of the intervening air; and if this resistance should prove too weak, what happens? How does the discharge show itself? It takes place in the form of a lightning flash, and passing from the one surface to the other—or, may be, simultaneously from both—produces neutrality more or less complete.

There has recently been a little discussion in these pages on the subject of lightning, some having stated that they discerned the discharge to take place upwards—that is, from the earth towards the cloud. I will not venture so far as to say whether or not the direction of the discharge is discernible; possibly the flash may sometimes be long enough to enable one to tell; but I have never so seen it, and have always looked upon the eye as a deceitful member—very. "The lightning flash itself never lasts more than $\frac{1}{100000}$ of a second." It is, however, just as likely that a discharge may travel upwards as downwards. What controls the discharge? Does the quality of the charge?—that is to say, is the positive or the negative more prone to break disruptively through the insulating medium? Investigations with Geissler's and other tubes containing highly rarefied gases have made it tolerably clear that there is a greater "tearing away" influence at the negative than at the positive pole, and if two equal balls, containing one a positive and the other a negative charge, be equally heated, the negative is more readily dissipated than the positive. But, so far as we at present know, this question enters into the discussion scarcely, if at all. Our knowledge seems rather to point to the substances upon which the charges are collected. The self-repellent nature of electricity compels it to manifest itself at the more prominent parts of the surface, the level being forsaken for the point. The tension of the charge, or its tendency to fly-off, is proportionately increased. And if at a given moment the tension attains a certain intensity, the discharge follows, emanating from the surface which offers the greatest facilities for escape. The earth is generally flatter than the cloud, whence, in all probability, the discharge more frequently originates with the cloud.

Should a lightning flash strike the earth and produce direct neutrality, it is possible that no damage will result, although this again is not always certain, because when the cloud-charge acts inductively upon the earth it produces the opposite (say negative) charge on the nearer parts, the similar (or positive) state is also produced at some place more or less distant. Sometimes this "freed" positive (which, by the way, accumulates gradually and physiologically imperceptibly) is collected at some portion of the earth's surface. When the negative is neutralised by the discharge, the freed positive is no longer confined to a particular region, but tends to dissipate itself, and a shock may be felt more or less severely by any person within the region. Or, again, a similar shock may be experienced by a person standing within the negative zone on the neutralisation of the charge.

I may take the opportunity here to mention a highly interesting and instructive incident observed on local telegraph circuits during a thunderstorm. The storm may be taking place at some distance from the point of observation. The electrified cloud induces the opposite charge beneath it, the similar charge being repelled. It is noticeable that the needle of a galvanometer, starting from the middle position, goes gradually over to one side, eventually indicating a considerable deflection. Suddenly, owing apparently to a lightning discharge some distance away, the force which caused the deflection is withdrawn, and the needle rebounds with great violence to the opposite side. In a short time, the cloud becoming again charged on its under surface, and recommencing its inductive effect upon the subjacent earth, the needle starts again, and goes through the same series of movements, a violent counter-throw following every flash of lightning.

If we can so far control our imagination, we may conceive the earth to be one large insulated conductor, susceptible to every influence around it. If, then, the earth, as a mass of matter, behaves as above indicated, there is no plausible reason for declining to regard any other large conducting mass in a similar light, and, as a body capable of being subjected more or less completely to the various impulses affecting the earth. In other words, a large mass of conducting material, partially or perfectly insulated is, during a thunderstorm, in considerable danger. With this portion of the subject I shall, however, deal more fully when discussing the merits of lightning protectors.

Lightning discharges do not take place between cloud and earth only, but also, and perhaps more frequently, between two oppositely-charged clouds. We then get atmospheric lightning, the flash often extending for miles. This form of lightning is harmless, and in all probability what we see is only a reflection of the discharge. The oft-told tale of the lightning flying in at the window, across the room, and out of the door, or up the chimney, is all moonshine, and before dealing with lightning-protectors I intend to expose some of the fallacies concerning lightning. Were the discharge to pass through a house it would infallibly leave more decided traces and do more damage than simply scaring a superstitious old lady now and again. Many people are often and unnecessarily frightened during a thunder-storm, but it may be safely predicted that a person under a roof is infinitely safer than one who is standing alone on level ground, and making himself a prominence inviting a discharge. Rain almost invariably accompanies the discharge, and the roof and sides of the house being wet, they form a more or less perfect channel of escape should a flash strike the building.

* We may speak of two electricities or two electric states without necessarily implying adherence either to the single or the double "fluid" theory. Whether electricity be of two kinds or no, the fact remains that there are two conditions, and all the features of this paper may be explained with equal facility by the supporters of either hypothesis.

GLASS-MAKING IN ITALY.—Colle de Val d' Elsa contains one of the most important glass-works in Italy. The value of the annual production amounts to 2,500,000 lire; its sale extends over all Italy, but more especially in the Roman, Tuscan, and Piedmontese provinces

THE EARTH'S SHAPE AND MOTIONS.

By Richard A. Proctor.

(*Continued from page* 109.)

CHAPTER I.—THE DAILY MOTION OF THE SUN.

THE first impression which the aspect of the earth and sky gives to the observer is that the earth is a vast plain over which the sky extends in the form of a dome. I propose in the present chapter to consider the lessons which may be learned from the most easily recognised of all the forms of motion which this dome presents to our contemplation.

Each day we see the sun rise towards the east, pass to the highest point of his path in the south, and then set towards the west.*

Now the diurnal motion of the sun is far more instructive than is commonly thought. To say merely that the sun rises towards the east and sets towards the west, is to mention nothing which can teach the real significance of the motion. For we might see an object apparently rise towards the east, culminate in the south, and then set in the west, while the real character of its motion was totally different from the sun's, and due to causes of another sort. It is the rate of the sun's motion and the figure of his apparent path which are so instructive. I will describe some simple observations which will show this.

Here in England, when the sun rises nearly in the east and sets nearly in the west—in other words, in spring and autumn—he attains in the south a height of about 38½ deg. Suppose, then, that we fix a rod in such a position that it will be square to a plane passing through the east and west point, and also through the highest point of the sun's path. In other words, let it have the position indicated in the figure, where N S represents the north and south line, E W the east and west line, O L (Fig. 1) the direction of the sun at noon, in spring or autumn, and O P the rod, which points towards the north, but is inclined

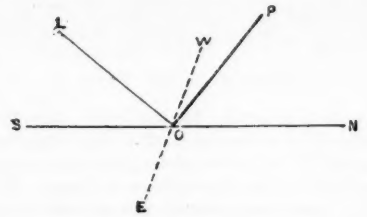


Fig. 1.

51½ deg. to the horizon (51½ being the angle, which with 38½ deg. makes up a right angle).

Now to the rod O P let the observer attach a cross-wire L K N at right angles to the rod, and another cross wire, K M, at right angles both to the rod and to L N; and let L K, K M, and K N be made equal. Then bend a strip of card or paper into a semicircular shape, and attach it, as shown in the figure, to the ends of the wire.

Set the rod in the sunlight in the position shown in Fig. 2, and so that the wire L K N may point east and west; no great exactness is required in this last respect.

Now at any hour observe where the shadow of O P falls on the strip of paper, as at R, and put a pencil-mark there. Half an hour later repeat the observation, and set another mark where the shadow now falls. Do this from half-hour to half-hour, or at shorter or longer intervals, as may be most convenient, only the successive intervals must be all equal, and carefully timed. Finally, remove the strip of paper, straighten it, and measure the spaces between successive marks. These will be found exactly equal.

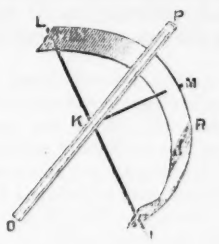


Fig. 2.

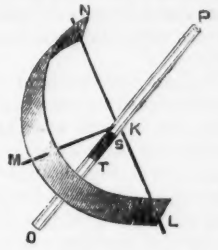


Fig. 3.

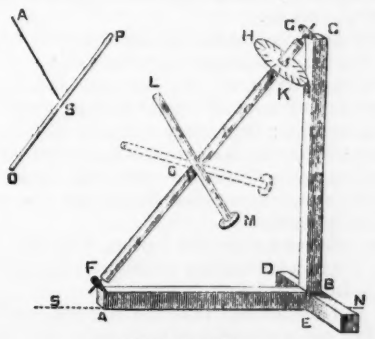
In describing this experiment I have for convenience spoken of a day in spring or autumn; because this gave the readiest way of showing how the position of O P was to be determined. But this position once fixed (in other words O P set up in such a way as to point towards the north at an angle of 51½ deg.) the same experiment can be tried on any day of the year with precisely the same result.

We have now learned an important truth about the rate of the sun's motion; we know that if a plane were taken always through O P and the sun, this plane would revolve uniformly on O P as an axis. But we want to know further what the shape of the curve traversed by the sun may be. This is easily accomplished by the same simple instrument. We have only to turn the rod O P on its axis, keeping its direction unchanged, until the circular strip has its centre towards the south, as shown in Fig. 3.

Then note where the shadow of the strip falls on the rod, as at S T; *it will be found that the position of the shadow remains unchanged throughout the day.*

Now, what does this result teach us? The following illustration will show:—

Suppose we attach to O P (Fig. 4) a straight rod A S, in



Figs. 4 and 5.

such a position that the point S coincides with the shadow of the upper rim of the paper strip, while S A just touches that rim. (The strip is removed from the figure for the sake of distinctness.) Then, since the sun's rays towards O P, crossing the top of the paper strip, fall at S, we can, by merely turning O P round on its axis without changing its position, make S A point exactly at the sun. And as

* I say towards the east and towards the west, for, as a rule, the sun does not rise exactly in the east nor set exactly in the west, and it is worth noticing in passing that in no place has the sun, since the world began, ever risen exactly in the east and set exactly in the west on one and the same day.

this is true at any part of the day, we can make S A follow the sun by simply turning O P *uniformly* (remembering what we have already learned about the rate of the sun's motion) on its axis.

Here, then, we have the simplest conceivable account of the sun's diurnal motion, we have a fixed axis O P pointing towards the north and inclined at an angle of 51½ degs. to the horizon. We have a straight rod S A, projecting from O P at a fixed angle determined for each day, by experiment; and by merely rotating O P uniformly on its axis, we can make S A point towards the sun all through the day.

We can now combine what we have learned in an instructive instrument which any handy person can construct with the utmost ease, and which will afford the most satisfactory information concerning the sun's daily motion.

A B, B C, Fig. 5, are two rods forming a right angle, and of such length that a line from C to A may be inclined 51½ deg. to A B. D E is a cross-rod for supporting A B C in an upright position. F G is a rod revolving easily in the pivot-holes at F and G. H K is a circle of card or other material, marked round its circumference with degree divisions. L M is a rod turning round on a pivot at O (the dotted figure shows the nature of its motion,) and bearing a small card circle M.

The instrument must be set upright, A B pointing due north and south, as shown. Then turn the rod F G on its axis, until L M can be made to point to the sun. It will be easy to know when this is the case by observing that when L M is pointing directly towards the sun, there will be no shadow of L M on the paper circle M. (The pivot on which L M turns should be so placed as to keep L M an inch or so from G F, and should also be perceptibly smaller in diameter than L M. When this is attended to it is easy to direct L M towards the sun by observing its shadow, and *making* this shadow disappear.)

The instrument is now ready for use. We note the division on the card H K which falls opposite the mark at K on the rod B C. Half-an-hour later, say, we inspect the instrument, and we find that L M now throws a shadow on the card M. We turn F G round on its axis until this shadow disappears. We find that this happens without our having occasion to shift L M, and we notice also that the card circle H K has to be turned through an angle of 7½ deg. At the end of another half-hour the same motion has to be repeated. And the same happens whatever day of the year it may be.

Now one day's observation of the sun with such an instrument teaches us this first important fact:—If E S P W represents the dome of the heavens, K L N the sun's diurnal path, O P a point towards the north 51½ deg. above the horizon; then every point of K L N is equally distant from P, *for the main axis of our instrument pointed throughout towards* P, *and the cross-rod, which we made to point to the sun, was inclined throughout at a fixed angle with that main axis.*

If, then, the sun's apparent motion were due to a real motion of his in a circle, that circle must have the inclined position K L M.

Again we have learned that the diurnal motion of the sun is either really uniform, or is apparent and due to some uniform motion of our earth's.

Again we have learned that our earth is not an infinitely wide plane, but that the sun rises from beyond the earth's limits on the east, and sets beyond the earth's limits on the west. For having found that our instrument follows the sun from the time of his rising fairly above the horizon, all through the day, until he approaches the horizon again in the west—by merely giving a certain uniform rotation to the axis F G, we are justified in assuming that there is no break in the continuity of this motion at sunset, but that by turning the axis round *after* the sun has disappeared, at the same rate at which we have moved it during the day, it will still point to his place. Now, doing this, we find the rod L M pointing below the horizon after

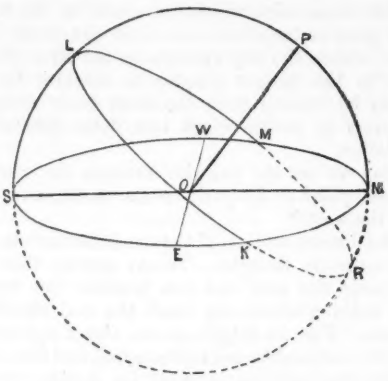


Fig. 6.

sunset. Further, by continuing the motion we find the rod L M pointing lower and lower until near midnight, when it is directed due north, and downwards, as towards R, in Fig. 6; then gradually it rises towards the east, and when it again becomes horizontal we find it pointing directly towards the rising sun.

(*To be continued.*)

THE ENTOMOLOGY OF A POND.

(*Continued.*)

By E. A. Butler.

LEAVING now the middle depths, which have detained us so long, and continuing our descent, we reach the

Bottom of the Pond.

The bottom of a pond can hardly be considered a particularly attractive abode, at least so far as appearances are concerned, and if one remembers its usual composition it will appear even less desirable as a home. Here is collected a fine mud, composed of the remains of all sorts of rubbish that is continually being rained down from the watery heights above. It is, as it were, the dust-bin, the cesspool, and the cemetery of the pond. Dust blown in from time to time by high winds, fragments of plants broken from aquatic vegetation, dead leaves and bits of stick fallen from the trees on the banks, the excrement of the insect and other inhabitants, together with fragments left from their repasts, empty shells of all sorts of water-snails, cast skins of larvæ, the dead bodies of the multitudinous aquatic population (and the mortality in a thickly populated pond must be considerable) together with those of worms and other terrestrial creatures that have had the misfortune to fall in and be drowned—these are some of the materials that, besides the mere earthy matter, help to form the ever-increasing mud at the bottom. There are, however, multitudes of minute creatures constantly at work on this refuse matter, dividing it up, and transforming the dead and effete materials into the living tissues of their own bodies, and thereby reducing the ultimate waste sub-

stance to a much smaller bulk, and rendering it innocuous to a degree that might at first seem impossible. Half buried in this mud, or slowly crawling over its surface, are the lurking monsters of entomological pond life, the majority of which belong to two orders we have hitherto scarcely noticed, the Neuroptera and Trichoptera, the former containing the dragon flies, and the latter the caddis flies. We will, however, first consider certain bugs which haunt these parts.

They are known as water scorpions, and two species inhabit this country, one commonly found in almost every pond, the other of much less frequent occurrence. They have, of course, no connection with the true scorpions, which are not insects at all, but eight-legged creatures belonging to the class containing spiders and mites. The water scorpions, too, unlike their terrestrial namesakes, are not venomous. The first, and much the less common, is

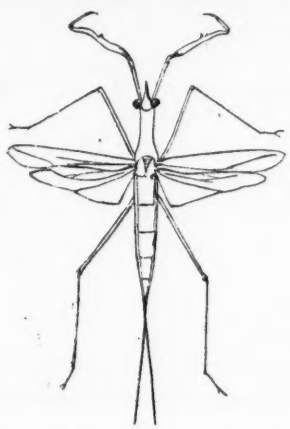


Fig. 1.—Ranatra linearis (reduced).

a long, narrow insect, called *Ranatra linearis* (Fig. 1). On account of its habit of frequently lurking in an inclined position amongst the water weeds, often only a little below the surface, this creature belongs less to the fauna of the bottom than its common relative. Still, they are best treated of together. It is of a brownish colour, except the upper surface of the abdomen, which is scarlet, but this is concealed when the insect is in the water, being made apparent only when the wings are expanded, and then it is quite astonishing to see what a beautiful creature the apparently uninteresting object becomes. The head is small, but the eyes exceedingly prominent, as is often the case with aquatic insects, and the beak short and sharp, not bent underneath, but projecting in front like an extremely acute nose. Both thorax and abdomen are elongated to an enormous extent; indeed, the insect, with a length of an inch and a-half from tip of snout to end of abdomen, has its greatest breadth no more than one-sixth of an inch. The upper pair of wings, while almost as long as the abdomen, are each only about half its width, but the hinder pair are considerably broader, and have to be carefully folded up before they can be stowed away under their narrow covers. These hind wings are beautifully delicate and transparent, similar, indeed, to those of the Corixidæ before referred to. But when we have reached the tip of the abdomen, we have by no means got to the end of the insect; from this point there extend two long bristle-like organs, about an inch in length, which project straight behind like a stiff tail; they are tubular, and communicate at their base with the tracheal system, and are, of course, respiratory in function. The legs are long and slender; the first pair are not used for progression, but for seizing prey, and it is these in front, and the respiratory filaments behind, that give the creature whatever resemblance it may have to a scorpion, although the similarity to that venomous animal is not nearly so exact as in the other species to be considered presently. The front legs are most remarkable objects, and will well repay a careful study. To understand clearly their peculiarities, we must first refer to the general plan of an insect's leg (Fig. 2).

Fig. 2.—(A) Fore-leg of Ranatra; (B) Leg of Stag-beet'e. *a*. Coxa; *b*. Trochanter; *c*. Femur; *d*. Tibia; *e*. Tarsus.

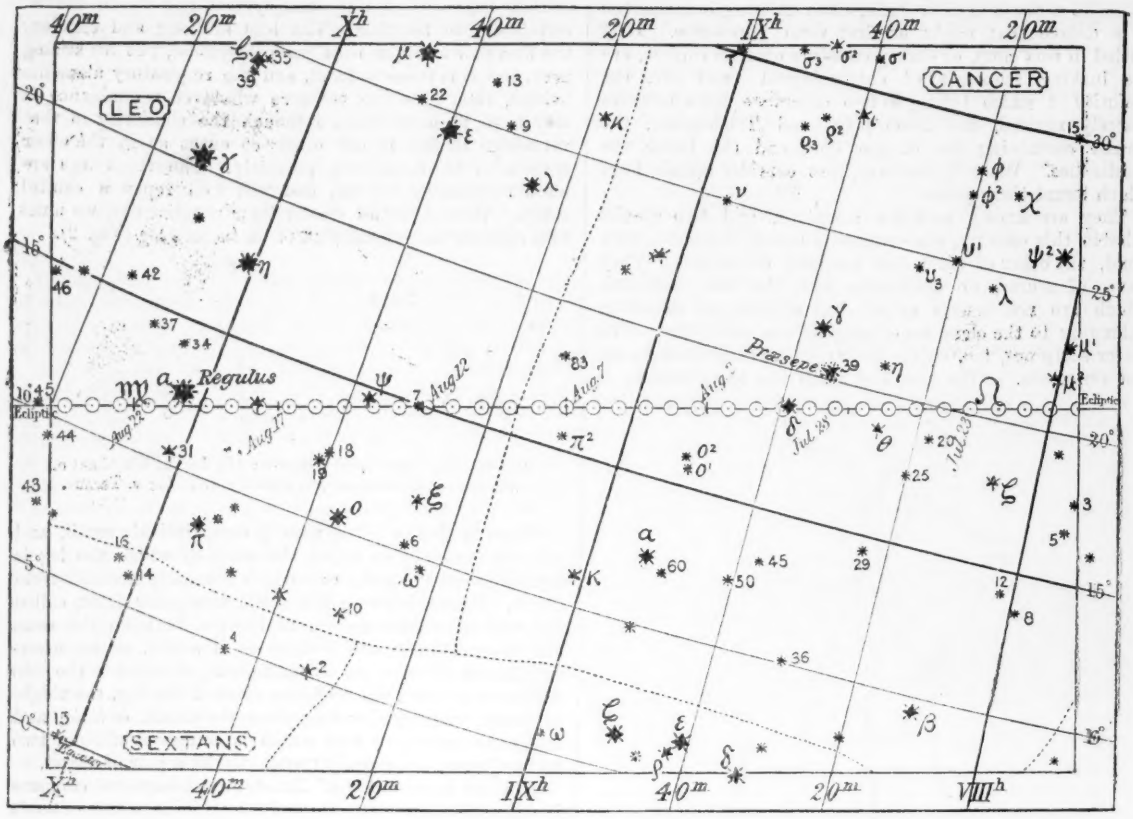
There is first a joint, usually comparatively small, and more or less globular, called the *coxa*, by which the leg is articulated to the body, and which is usually invisible from above. Succeeding this is a small triangular joint, called the *trochanter*, squeezed in, as it were, between the coxa and the next joint, and looking as if added, as an afterthought, to fill up a gap. Then follows, attached to the side of the trochanter, the first long piece of the leg, the thigh, or *femur*, then another long piece, the shank, or *tibia*, and lastly the *tarsus*, or foot, which is composed of from two to five joints, and usually terminated by a pair of claws.

Now let us take one of Ranatra's fore-legs and compare it with this plan. First we find a long joint, which extends far beyond the head, but still, from its being that which articulates the leg to the thorax, we know it must be the coxa, though it protrudes so far that we may easily at first mistake it for the thigh. Then there is the trochanter, a little larger and more conspicuous than usual, and this is succeeded by a long piece slightly curved at the further end, and with a tooth a little beyond the middle; this, of course, is the femur. After this there is a short, sickle-shaped part, less than half the length of the femur, and looking like a great claw; it is able to be folded back upon the inner edge of the femur, along which a narrow groove, serrated at the edges, is excavated to receive it, and then its tip just reaches the above-named tooth. This sickle-shaped part consists of both tibia and tarsus, the latter of which is very small and has no claws. It will thus appear that the leg proper is, as it were, spliced on to the end of a long handle, the elongated coxa, an arrangement the effect of which is to give the limb much greater freedom of motion and a much wider sweep, and thus to enable it to levy tribute over a much more extended area. So peculiar is the plan of these limbs that it is no wonder that many persons have been puzzled to understand them.

We must leave the habits of Ranatra for consideration in the next paper.

(To be continued.)

The French Electrical Power Storage Company.—Vice-Chancellor Bacon made an order on Saturday week for the winding-up of this Company on the petition of the Faure Electric Accumulator Company. It was stated in court that the proceeding was rendered necessary by the frauds of M. Phillippart, whose name has been so intimately associated with electric lightning and accumulators.



Day Sign for the Month.

ZODIACAL MAPS.

By Richard A. Proctor.

WE give this week both the day sign and the night sign for the month, one showing the zodiacal sign now high in the heavens at midnight, the other showing the region of the zodiac athwart which the sun pursues his course at this part of the year.

OTHER WORLDS THAN OURS.

A WEEK'S CONVERSATION ON THE PLURALITY OF WORLDS.

By Mons. de Fontenelle.

WITH NOTES BY RICHARD A. PROCTOR.

(*Continued from p.* 118.)

"BUT pray," said she, "how can the earth with all its weight, be borne up by your celestial matter, which must be very light, because it is so fluid?"

"It does not argue," said I, "that what is most fluid is most light: for what think you of the great ship I mentioned just now, which with all its burden is yet lighter than the water it floats on?"

"I will have nothing to do with that great ship," said she, with some warmth, "and I begin to apprehend myself in some danger on such a whirligig as you have made of the earth."

"There is no danger," replied I; "but, madam, if you are afraid, we will have the earth supported by four elephants, as the Indians believe it."

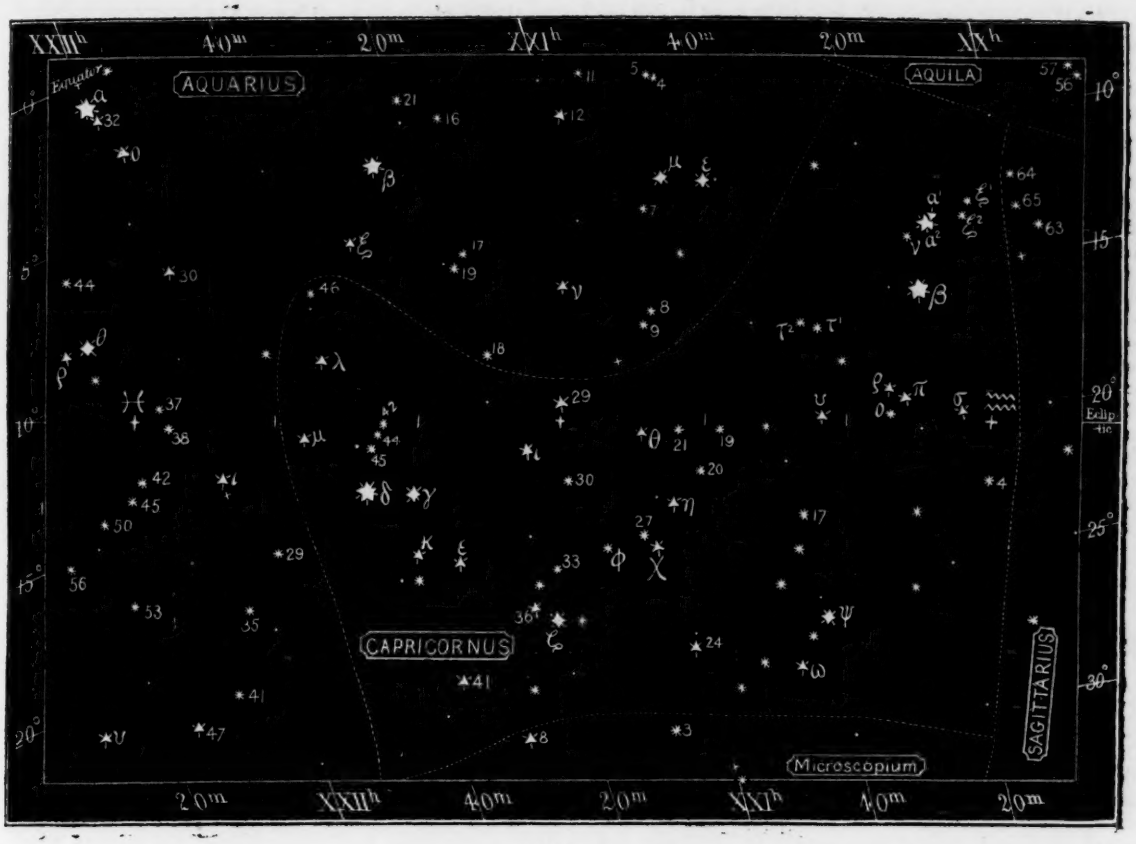
"Hey-day," cry'd she, "here's another system; however, I love those people for taking care of themselves; they have a good foundation to trust to, while you Copernicans are a little too venturous with the celestial matter: and yet I fancy, if the Indians thought the earth in the least danger of sinking, they would double their number of elephants."

"They would do well," said I, laughing at her fancy, "who would sleep in fear? and if you have occasion for 'em to-night, we will put as many as you please in our system; we can take 'em away again by degrees, as you grow better confirm'd."

"I do not think 'em very necessary," said she; "I have courage enough to turn."

"You shall turn with pleasure, madam," said I, "and shall find delightful ideas in this system: For example, sometimes I fancy myself suspended in the air, without any motion, while the earth turns round me in twenty-four hours; I see I know not how many different faces pass under me, some white, some black, and some tauny; sometimes I see hats, and sometimes turbans; now heads with hair, and then shav'd heads; here I see cities with steeples, others with spires and crescents, others with towers of porcelain, and anon great countreys with nothing but cottages: here I see vast oceans, and there most horrible deserts: In short, I discover the infinite variety which is upon the surface of the earth."

"I confess," said she, "twenty-four hours would thus be



Night Sign for the Month

very well bestow'd, so we were in the same place where we are now: I do not mean in the Park; but we will suppose ourselves in the air, other people continually passing by, who take up our place, and at the end of twenty-four hours we return to it again."

"Copernicus himself," said I, "could not have comprehended it better. First, then, we see some of our neighbours passing by us, up to the ears in politics, yet settling their nation no better than we do the world in the moon; then follows a great sea, perhaps a fleet of ships, perhaps a mackrel-boat, no matter whether; then come some of the Iroquois going to eat a prisoner for their breakfast, who seems as little concerned as his devourers; after, appear the women of the land of Jesse, who 'spend all their time in dressing their husband's dinners and suppers, and painting their lips and eyebrows blue, only to please the greatest brutes in the world; then the fair Circassians, who give all their love to the first comer, except a little they reserve for their husbands; then the Tartars going to steal concubines for the Turks and Persians; and at last our own dear countrymen, it may be in some points as ridiculous as the best of 'em."

"It is very pleasant," said the Marchioness "but to imagine what you tell me; tho' if I were above, and saw all this, I would have the liberty to hasten or retard the motion of the earth, according as the objects pleas'd me more or less; and I assure you I should quickly send packing the politicians and man-eaters, but should have a great curiosity for the fair Circassians, for methinks they have a custom very particular. But I have a difficulty to clear, and you must be serious. As the earth moves, the air changes every moment, so we breathe the air of another country."

"Not at all," replied I, "for the air which encompasses the earth does not extend above a certain height, perhaps twenty leagues; it follows us, and turns with us. Have you not seen the work of a silkworm, the shells in which those little animals imprison themselves, and weave with so much art? they are made of a silk very close, but are covered with a down very slack and soft: so the earth, which is solid, is covered from the surface twenty leagues upwards with a kind of down, which is the air, and like the shell of the silkworm turns at the same time. Beyond the air is the celestial matter, incomparably more pure and subtle, and much more agitated than the air."

"Your comparison," said she, "is somewhat mean, and yet what wonders are wrought, what wars, what changes in this little shell."

"'Tis true," I replied, "but nature takes no notice of such little particular motions, but drives us along with the general motion as if she were at bowls."

"Methinks," said she, "'tis very ridiculous to be upon a thing that turns, and yet not be well assured that it does turn; and to tell you the truth, I begin to distrust the reasons you give why we should not be sensible of the motion of the earth; for is it possible there should not some little mark be left by which we might perceive it?"

"All motions," said I, "the more common and natural they are, are the less perceptible; and this holds true even in morality. The motion of self-love is so natural to us,

that for the most part we are not sensible of it, and we believe we act by other principles."

"You are moralising," said she, "to a question of natural philosophy: But 'tis enough for the first time; let us now go home, and meet here again to-morrow, you with your systems, and I with my ignorance."

In returning to the Castle, that I might say all I could on the subject, I told her of a third system, invented by Tycho Brahé, who had fixed the earth in the centre of the world, turned the sun round the earth, and the rest of the planets round the sun; for since the new discoveries, there was no way left to have the planets turn round the earth. But the Marchioness, who had a quick apprehension, said, she thought it was too affected, among so many great bodies, to exempt the earth only from turning round the sun; that it was improper to make the sun turn round the earth, when all the planets turn round the sun: and that tho' this system was to prove the immobility of the earth, yet she thought it very improbable. So we resolv'd to stick to Copernicus, whose opinion we thought most uniform, probable, and diverting. In short, the simplicity of his system convinces us, and the boldness of it surprises with pleasure.

(To be continued.)

REMARKABLE STORMS IN BELGIUM.

A NUMBER of very remarkable storms occurred in Belgium in July, 1884, and the following account is taken from reports made to the Observatory at Brussels. On the 4th, at Lamorteau, near Virton, from 2h. 34m. to 5h. 22m. p.m., there was a storm wind, and during eighteen minutes a great fall of hail, making the fields look as if thickly covered with snow. The hailstones were at first the size of nuts, and then of large peas. At Thirimont, near Beaumont, on the 5th, the hail was the largest ever known there. The stones had sharp angles, and did great damage to crops. The storm did not extend beyond a radius of 1,500 mètres. On the 13th, at Bruges, during a severe storm, the sky looked as if instead of clouds there were vast eddies of smoke from a huge fire, reflecting flames. The movements of the lower clouds increased in rapidity, the wind rose to a hurricane, and snapped great branches off the trees. Transparent hailstones fell for five or six minutes, the size of small nuts. At Maldegem, east of Bruges, almost at the same time, there was a deluge of rain mingled with pieces of ice from 25 to 40 millimètres in diameter (1 inch to 1½). They were round, lenticular, and angular, striking the ground with extraordinary force. A water-spout passed within 3,000 mètres, destroying hundreds of trees. At Ostend, on the same day, some hailstones were as big as pigeons' eggs and some as big as fowls' eggs. One of these, when cut in the direction of its longest diameter, exhibited a nucleus, surrounded with successive layers, alternately transparent and opaque. The surface was very irregular, with clear protuberances. At Haesrode, near Louvain, at 2.30, on the 13th, a small white cloud appeared and suddenly discharged hailstones as big as eggs, one weighing over 8 oz. They varied in shape—oval, hemispherical, triangular, and some spinous, like a prickly pear. This storm only lasted three or four minutes, and only extended over the small space of from half a mètre to a mètre! At Hechtil (Limbourg), on the same date, hailstones fell over 3 inches in diameter.

During the storm of July 13, Baron van Ertborn, at Aartselear, near Antwerp, examined with a telescope a large cloud 50 deg. above the horizon, and saw that it was formed of seven superposed layers, the lower ones eddying and moving quickest. Curved flashes of lightning darted from one layer to another. On July 17, near Arlon, pieces of ice fell 3 to 3½ inches in diameter, breaking glass, killing poultry, and cutting fruit-trees. Storms of this kind are said to be very rare in Belgium. S.

THE INTERNATIONAL HEALTH EXHIBITION.

XII.—WATER AND WATER-SUPPLIES—(*continued*).

THE description of Mr. Roberts's "Rain-Water Separator," given in our last communication, is an apt introduction to the subject of water-purifying appliances, which we now propose to deal with. In the "East Central Gallery B," may be seen, in active operation, all the forms of apparatus that are of any value in the present enlightened day, when Darwin's great law of the "survival of the fittest" holds its sway more powerfully than ever. The plan we have chosen to adopt in our remarks upon the inventions here displayed, is to place before our readers a descriptive account of the *types* that have been resorted to in gaining certain desired ends, rather than a serial discourse upon the relative merits of the various patents. In illustration of these principles, we shall select the most suitable examples at our disposal, so that our series of reviews shall embody a digest of the highest possible value for those who wish to exercise their own discretion in the choice of what we deem to be one of the most essential requisites in every household—a good filter.

Type I.—As a natural sequence of the rain-water separator, which is adapted to procure a supply of good soft water suitable for all domestic purposes, save drinking,* we would draw attention here to "Stall 420," and the "Grant Revolving Ball Water Filter," the value of which lies in the fact that a tolerably pure water, such as that derived from a Roberts Separator, or delivered to town and suburban dwellings by water companies, may be rendered fit for drinking in an incredibly short space of time. It is, without doubt, the best rapid water filter for the above-mentioned sources of supply; it can be fastened on to any existing water-pipe with the utmost ease; may be as readily cleansed and re-charged with the filtering medium; and, when "turned on full," there is but a slight, almost inappreciable, diminution in the rapidity of flow from the tap. We can safely recommend this filter to the notice of those who desire to have an unlimited supply of good, pure water always readily available, more especially in the kitchen; and to convince our readers of its practical utility, we cannot do better than give an outline of its general anatomy. So far as we are aware, this type of filter stands alone—it has not yet been copied; in one particular, however, it may be placed amongst the so-called high-pressure filters.

The "Grant Revolving Ball Water Filter" consists of a spherical metallic case, the smallest manufactured size of which, for domestic purposes, is about 2 inches in diameter, and under pressure from the tap diminishes the ordinary rate of delivery by about only 20 per cent. Within the case there is a hollow metal ball, designed to hold the filtering medium (granular animal charcoal), and every drop of water which passes into the mechanism is forced

* In making this proviso, we desire it to be understood that, in most cases, the rain-water obtained through the use of the Roberts "Separator," may be also used for drinking; but it is well to purify it still further by efficient filtration, so as to render the result doubly secure.

to percolate through the filter. This is secured by a washer, which forms a tight joint a round the ball. The water may be permitted to pass through unfiltered along the passage B B, Fig. 21; but when the packed handle C is revolved so as to bring the filter into operation, the water

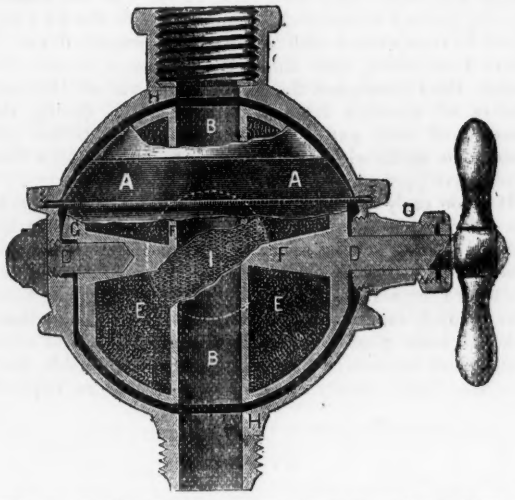


Fig. 21.—Sectional view of "*The Grant Revolving Ball Filter.*" A A, patent cup and joint washer, packed by pressure of water; B B, direct way for water through ball *without filtering*; C, packed handle to revolve ball; D D, bearings upon which ball revolves; E E, animal bone, charcoal, or filtering medium: F F, bars inside of ball upon which the water strikes when filtering, preventing drilling of charcoal; H H, shell containing ball; I, section of wire screen or sieve which holds charcoal into the ball, and through which water passes when filtering.

strikes upon the bars F F, thus breaking its initial force, and causing it to spread over the whole body, whence it finds its way through the charcoal with an equalised pressure, thereby securing perfect filtration with a minimal disturbance. The matters which accumulate in the filter may be removed by a simple revolution of the ball, and the entire system thus cleansed in a few seconds. An objection to this method of cleansing is, that it is at most only approximately effective, but that is all that is really necessary in a filter of this kind; and, moreover, should the objector be unusually fastidious, he may, at the worst, remove the charcoal, wash it thoroughly, and return it to its receptacle, or supply its place with a fresh charge, which is easily done at but a nominal expense. The entire apparatus is inexpensive, portable, almost indestructible, effective, and even elegant; it speaks very highly for the ingenuity of its transatlantic inventor. The carbon recommended for use is in a sufficiently fine state of division to act as a thorough mechanical strainer; it also acts chemically, if we are to judge from analyses of the filtrate.

Type II.—Although we strongly object to the old-fashioned "block" principle in filters, we are constrained to admit that there are some of them which it would be unjust to leave unnoticed, since they achieve results which place them amongst the best of modern inventions. Of these, "Doulton's Manganous Carbon Filters" deserve a special notice; they may be seen and tested in the western annexe of their Pavilion in the "Central Gallery."

Before we proceed to describe the action of these filters, we desire to draw attention to one of the most important features in the construction of filter-cases which is strikingly exemplified in Messrs. Doulton's patent. These are the only filters extant where anything of the kind has been adopted. Fig. 22 will help us to explain more clearly than any written description alone, how every drop of filtered water becomes available, and is prevented from getting stale by the gentle slope of the floor of the reservoir to the tap, which is situated below the level of that floor. In most filters this item is generally overlooked, with the consequence that the lowest stratum of water may lie unused within the reservoir of the filter sufficiently long to become either mawkish or positively harmful through the accidental introduction of aërial germs, which usually gravitate to the bottom of the water. To this class belong certain forms of the minuter *Algæ* and *Rotifera*, not to speak of *Bacteria*, which in their totality may, and almost always do, produce, in about ten or twelve days, an undesirable adherent slimy layer at the bottom and lower sides of the reservoir. This state of affairs may be observed in the form of filter-case shown at Fig. 23, where the position of the tap necessitates a constant remnant of unusable water, which has therefore to be cleansed out periodically. As the majority of filters now in use are all modelled upon the type of Fig. 23, we would here offer our practical advice to such of our readers as may possess filters of this sort, which is:—To be careful to thoroughly wash out the reservoir at least once a week; this will be sufficient to insure them against the possible sources of contamination to which we have alluded.

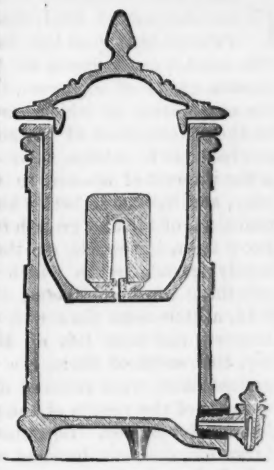


Fig. 22.

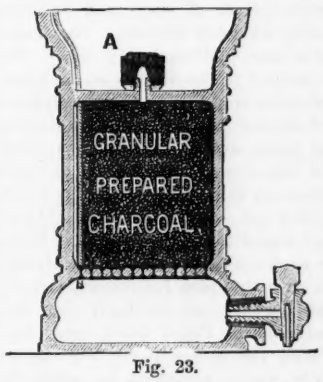


Fig. 23.

Another praiseworthy fact about Doulton's filters is, that their taps are made of stoneware, and hence are not liable to the inevitable corrosion, to which metal taps are subject, which, if not positively dangerous, are at least objectionable on the score of cleanliness.

We would, of course, expect to find elegantly-shaped and beautifully-decorated filters at Messrs. Doulton's, nor are we doomed to disappointment. Apart from strict utility there is an indescribable charm about an artistically finished production, such as that represented at Fig. 24, which raises it above the commonplace, to rank amongst the things that are to be desired.

Fig. 24.

THE GREELY EXPEDITION.

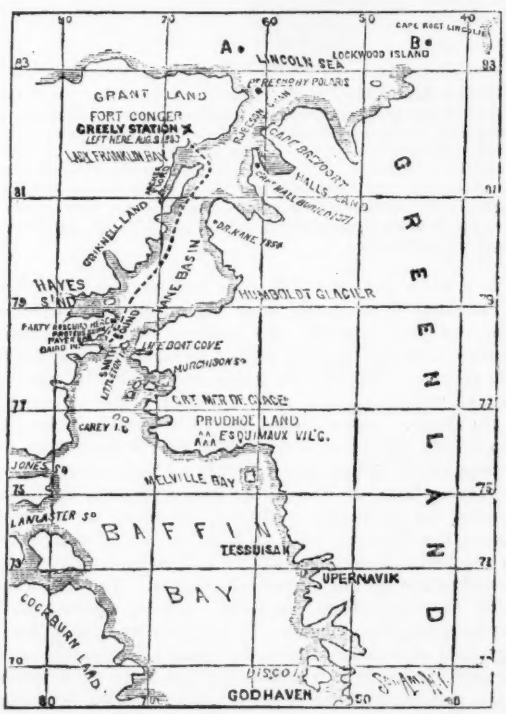
IT was August 18, 1881, that the officers and crew of the *Proteus* bade good-bye to Lieutenant Greely and his little band, twenty-five in all, leaving them in camp, as an advance guard of explorers, in a high northern latitude. The exploration in which they were engaged was not one for the advancement of material aims or the ambition of governments to enlarge their dominions—it was one solely in the interest of science, to widen the domain of knowledge, and help us to better know the laws which affect the conditions of life and growth on this planet, as well as to throw light, if possible, on that great field of research, so largely speculative, in which we are seeking to find out something of the universe. It was not until June 22, 1884, a little more than two years and ten months after the party had been left on the shores of Lady Franklin Bay, that seven of them, the only living members of the original band, were relieved of their long vigil by the appearance of the vessels of the government expedition under Commander Schley. Seventeen of the others had died of starvation, one was drowned while sealing to obtain food, and of those found alive one died subsequently from the amputation of limbs made necessary by frost bite, so that only six of the original twenty-five remained alive to reach home again.

The story of the expedition, the plans of the scientific bodies and Arctic explorers which led up to it—in connection with several other observation posts around the pole—as well as the futile efforts of 1882 and 1883 to reach and relieve the colony at Lady Franklin Bay, have often been told. It was the understanding when the station was established—subject to the discretion of Lieutenant Greely, as circumstances might affect the situation—that if government relief did not reach the station during the summer of 1882, the party would endeavour to work its way southward in the summer of 1883 as far as Cape Sabine, or make its quarters on the west coast as far south as might be practicable, and yet within the possibility of being reached by a relief expedition, but that the route would be on or along the west coast, and not on the Greenland side. In accordance with this idea Lieutenant Greely abandoned his quarters at Fort Conger, on Lady Franklin Bay, August 9, 1883, and reached Baird Inlet, near Cape Sabine, September 29, with the entire party well up to that time. Great difficulty was experienced in getting to that point, with the instruments and records of observations, and as large a supply of provisions as it was possible to convey. He was obliged to abandon all his boats, and was adrift for thirty days on the ice in Smith's Sound, the party finally making its way across an almost impassable field of ice hummocks to a landing just north of Cape Sabine, where a permanent camp was established October 21.

Here the party found that a very insufficient supply of provisions had been left, while some of those thus obtained had been left by Sir George Nares as long back as 1875, and were, of course, much damaged. It was known that supplies had been left on Littleton's Island, almost opposite Cape Sabine, on the east side of Smith's Sound; but the channel did not close all the winter on account of violent gales and strong currents, and there was no means of reaching the food that was so near. The party was immediately put on short rations, but on May 14, 1884, the last regular food was issued. After this the men were forced to live on boiled sealskin strips from their sealskin clothing, lichens, and shrimps, game having failed, despite daily hunting, from early in February.

One had died in January, 1884—the first death of the party—then five died in April, four in May, and seven in June, up to the 22nd, when the rescue was made, and when, according to Commander Schley, "forty-eight hours' delay in reaching them would have been fatal to all." Too high praise cannot be accorded to Commander Schley for the energy with which he pushed north so early in the season, fighting his way almost inch by inch through the ice; but it will be remembered with a feeling of sadness, if not of severe reprobation, that three United States vessels, the *Yantic*, the *Proteus*, and the *Neptune*, had visited the near locality of Greely's fatal camping-ground, during the summers of 1882 and 1883, with ample provisions, and came home again without leaving there the supplies that would have prevented these men from starving.

It is too early to say what will be the probable value of the information obtained by this expedition. Up to the fall of 1883 its success seems to have been all that could have been desired by its promoters, and in the journey southward copies were brought of meteorological, tidal, astronomical, magnetic, pendulum, and other observations, although some photographs, Esquimaux relics, and other things were necessarily left behind. It is probable, however, that Lieut. Greely made all the observations required



by the International Conference at Hamburg, under whose directions the various circumpolar stations were established, and that substantially all such records have been saved. The distinguishing work of the expedition—that which will perhaps give it most fame—is thus announced by Lieut. Greely: "For the first time in three centuries England yields the honor of the furthest north," which had previously been 83° 20′, but was marked at 83° 24′ by Lieut. Lockwood, of the Greely expedition, on May 13, 1882. The point of observation was named Lockwood Island, where, "from an elevation of 2,000 feet, they saw no land north or north-west." To the east and north-east of Lady Franklin Bay the party undoubtedly made the best survey yet

accomplished of northern Greenland, and, by observation of what seemed to be a distant headland, located it as Cape Robert Lincoln, in latitude 83° 35′, longitude 38° west of Greenwich.

At B, in our map, is shown Lockwood Island, the highest northern latitude yet reached, and from whence the observation was made, while A marks the highest point attained by Commander Markham, the most successful British explorer in 1876. In a subsequent endeavour to go still farther north, the party was turned back by open water, and, as Greely's report says, "barely escaped drifting into the Polar Ocean."

There are many other newly-named places, and some material changes will have to be made in the maps of regions hitherto incorrectly laid out, along the west shore of Kane Basin and Kennedy Channel, and in the configuration of Grinnell Land, and the north shores of Grant Land and Greenland. Arctic geography will thus, doubtless, be greatly amended, but whether the results attained will prove sufficient compensation for the loss of life of the brave men who were sacrificed is a query which many people will think most unsatisfactorily answered.—*Scientific American.*

Reviews.

SOME BOOKS ON OUR TABLE.

An Introduction to Mental Philosophy, on the Inductive Method. By J. D. Morell, A.M., LL.D. (London: W. Stewart & Co.) As an introduction to the study of psychology, at once scientific and popular, it would be difficult to find a work better adapted to its avowed purpose than that whose title heads this notice. While omitting nothing essential to a complete theory of the nature and modes of action of the human mind, it is yet commendably free from that redundance of verbiage which unfortunately distinguishes so many works on mental science; though while as succinct as need be, it never degenerates into baldness, or slurs over a difficulty for want of detail in the argument adduced to meet it. Dr. Morell begins *ab initio* with the primordial forms of mental activity, and, proceeding through the nature and development of perception, and subsequently of ideas, traces the logical processes of the human mind from the latter. In subsequent divisions of his work he necessarily deals with human reason, the development of the will, and the feelings generally; concluding with an appendix of very numerous examination papers in mental and moral science set for degrees in the London University. The reader who has been taught to regard everything in the shape of metaphysical or psychological disquisition as essentially dreary will undeceive himself very agreeably by the perusal of Dr. Morell's book; while the student more familiar with mental science may read such chapters as those on belief and on the freedom of the will by no means without profit. The work has one solitary defect, which we trust to see supplied in the next edition—it has no index.

Manual of the Mosses of North America. By Leo Lesquereux and Thos. P. James. (London: Trübner & Co. 1884.)—To every practical bryologist this wonderful specimen of patient and enduring labour of Messrs. Lesquereux and James will be welcome, containing as it does a detailed description of something like nine hundred species of the mosses found on the American continent; in fact, presenting a practically exhaustive account of every one so far known there. It is illustrated with six beautiful plates, crowded with figures, illustrating the genera; and must be indispensable to every one interested in the lowly type of vegetable organisms with which it so ably deals.

How to Foretell the Weather with the Pocket Spectroscope. By F. W. Cory. (London: Chatto & Windus. 1884.)—In or about the year 1872 Professor Piazzi Smyth, the Scottish Astronomer Royal, discovered that when moisture was present in the air a band or shading appeared in the spectrum of the light of the sky, on the less refrangible side of the well-known D, or sodium, lines. The result of a series of observations induced him to believe that the spectroscope might thus be employed as a hygrometer, or, speaking more rigidly, a hygroscope, to foretell the advent of rain; and, impressed with this idea, he published his discovery to the world. The matter was taken up in England by Mr. Rand-Capron and a few others, but very considerable difference of opinion seems to have prevailed as to the value of the method; and, during the autumn of 1882, the columns of the *Times* were the scene of a pretty lively conflict of opinion on this subject. Mr. Cory, however, appears to have given the spectroscope a pretty fair trial as a means of forecasting rain, and claims to have been quite successful in his vaticinations. To all who wish to follow his footsteps, his little book may be commended; as he gives the plainest possible directions for the use of the instrument to predict rain, illustrated in a way which renders his descriptions almost equivalent to personal instruction. The method is worth a trial, at any rate.

Editorial Gossip.

The devotees of the science or art, or whatever it is, of "Philately" may be interested to learn that up to the end of the year 1883 two hundred and three countries, states, &c., and twelve private companies had issued adhesive postage-stamps. Of these, sixty-nine have also issued envelopes, and one hundred and seven, post-cards. Between 1840 and Dec. 31, 1860, 2,400 stamps of sorts were issued. From 1861 to December, 1870, sixty-six new countries were added, and the stamps rose in number to about 6,400, an increase of 4,000 in ten years. In the next decade forty-nine new countries were added to the list, and another 4,000 was added to the number of adhesive stamps. Finally, the number of stamps which, up to Dec. 31, 1880, was about 10,400, had advanced to about 12,000 in the succeeding three years, or at the rate of more than 500 a year; so that if the same rate of progression should continue, by December, 1890, 16,000 varieties of postage-stamp will be in existence. When I read all this in the pages of Messrs. Alfred Smith & Co.'s *Monthly Circular*, I tremble to think of the sorts and sizes of Stamp Albums that it will be incumbent on the collector of five or six years hence to keep. A moderately complete collection will require a perambulator, at the least, for its transport from place to place; while a really full one will scarcely be movable in anything short of a donkey-cart.

I have just obtained what is expressively known as "a wrinkle" from a wholesale price-list of a distiller which has fallen (no matter how) into my hands. That it was never intended to be seen by any mortal eyes outside of "the trade" goes without saying. In this highly-instructive document I find, under the head of "Spirit Flavours," "the attention of consumers in Australia and India" (we needn't say anything about England) "is particularly called to these very useful and excellent flavours. One pound of either of these essences to fifty gallons of plain spirit" (let

us suppose potato spirit) "will make immediately a fine brandy or old tom, &c., without the use of a still.—See *Lancet* report." This is followed by a list of prices of these "flavours," and then follows a similar one of "Wine Aromas." A cheerful look-out all this presents, upon my word! The confiding traveller calls at his inn for some old brandy, and they make it in the bar while he is waiting. He orders a pint of claret or port, and straightway he is served with some that has been two and a half minutes in bottle! After the perusal of this price-list, I have come to the conclusion that in the case of no articles of consumption whatever is the motto *Caveat Emptor* more needful to be attended to than in that of (so-called) wines and spirits.

Quem Deus vult perdere dementat prius. Towards the end of last year public attention was prominently directed to a "Dr. Samuel Kinns, F.R.A.S.," who, after proclaiming his crass ignorance of science in a book called "Moses and Geology"—or by some such title—set forth, a blind leader of the blind, to lecture on the Harmony of the Bible with Science and History. He claimed to have the sanction and support of, *inter alios*, members of the staff of the British Museum, but this was promptly denied and repudiated by more than one leading member of that staff themselves. "Dr." Kinns's sciolism and ridiculous blunders were thereupon so thoroughly exposed that I, among the vast majority of English men of science, fondly hoped that we had heard the last of him. Now, to my unbounded surprise, I find it stated in the newspapers that "Lord Shaftesbury, the Bishop of Bath and Wells, the Lord Mayor, Rabbi Ascher, and other influential gentlemen" have sent a preposterous resolution to the press, affirming that "eminent men connected with our highest scientific institutions" have borne "public testimony to the accuracy of Dr. Kinns's work, 'Moses and Geology,'" . . . and so on, and so forth. In the face of this manifesto, I think that *real* scientific men have a distinct right to demand that my Lords Shaftesbury, A. C. Hervey, and R. N. Fowler, together with the Rabbi Ascher and Co., shall furnish the names of those "eminent men connected with our highest scientific institutions" to whom they so vaguely refer. Surely the right honourable and noble Lords and the Reverend Rabbi do not ask the British public to accept *their* dictum on a question of science? I write strongly, because I feel strongly, on this question. Myself a Fellow of the Astronomical Society, I do not even know Dr. Kinns by sight, but I have an abiding conviction that such books and lectures as his do more fatal mischief to religion than all the efforts of Messrs. Aveling and Bradlaugh put together. "Let" says the old proverb, "sleeping dogs lie." Dr. Kinns and his rubbish had practically vanished from public view. If, however, he is to be dragged forward again, and made a pseudo-hero and martyr by such most ill-advised friends as the Mansion House Committee, we may not impossibly hear of a counter series of lectures to his, exposing his ignorance, and laying bare his fallacious results. It strikes me with very considerable force, that orthodoxy will come off decidedly "second-best" in such an encounter, unless it can secure some very much more competent champion than the "F.R.A.S." who thought that the Sun could continue visible, by abnormal refraction, above the *western* horizon, after he had risen in the east!!!

In the current number of the *Asclepiad*, there is a paper (presumably by its Editor, Dr. B. W. Richardson, F.R.S.), on "Euthanasia for the lower creation," in which the author advocates the administration of some anæsthetic, preferably carbonic oxide, to narcotise sheep, lambs, calves, and smaller animals, prior to handing them over to the slaughterer. He does not propose to interfere with the present method of killing oxen, in which I think he shows his wisdom; inasmuch as it seems impossible to conceive any more rapid and effective a means of producing insensibility than the use of a properly-wielded pole-axe.

I am sincerely glad to see that the fine collection of works of art now brought together at St. Helen's is open on Sundays. The suicidal policy which simply leaves the working man his choice between Church and the Beershop must at no very distant date yield to the more rational system of affording him the means of elevating and refining his mind, and so weaning him from gross and sensual pleasures.

Our contemporary, *Society*, writing apropos of the gallantry of the two constables shot by the Hoxton burglar, makes the excellent suggestion that an Order for Civil Courage should be instituted, akin to the Victoria Cross already given for conspicuous personal bravery in the field. It would be a pleasant greeting for Garner and Snell, on their discharge from the hospital, to have such a "C. C." pinned to their breasts.

"Some gorgeous sunlight effects," says the *Standard*, "have been observed over the Yorkshire wolds for several nights past. The sky has been one mass of richly-blended colours, commencing at the horizon with a broad belt of deep yellow light, and then tier above tier of orange and purple, the latter colour predominating in horizontal streaks, whilst the sky above was flooded with a magnificent glow from the setting sun." I wonder whether any of the members of the Krakatoa Committee of the Royal Society have been "kicking up a dust" in the East Riding within the last week or two?

THE FACE OF THE SKY.

From August 15th to August 29th.

By F.R.A.S.

The Sun will, as usual, be examined on every clear day for the spots and faculæ which continue to appear on his disc. The August night sky will be found delineated in Map VIII. of "The Stars in their Seasons." A minimum of Algol ("The Stars in their Seasons," Map I.) will occur at 8h. 12m. p.m. on August 18th. Mercury is an Evening Star, and attains his greatest elongation east of the Sun (27° 16′) at 5 p.m. on the 23rd. Unfortunately at this time he only sets about half an hour after the Sun, so that the chances of detecting him with the naked eye are very small. Venus is a Morning Star throughout the month, and is at her greatest brilliancy on the 17th. About this time she may be picked up perfectly well by the naked eye near the time of her passage over the meridian. This occurs at 9h. 20m. a.m. on the 17th, and something like a couple of minutes sooner on each succeeding morning. At this time she looks, in the telescope, like the Moon when she is about four days old. As far as the remainder of the planets are concerned, the night sky is a blank. As the Moon is new on the night of the 20th, and does not enter her first quarter until 42 minutes past 3 o'clock in the afternoon of the 28th, she will only be visible for the purpose of the ordinary observer during about the last three or four days to which these notes have reference. She will only occult one star in the course of the fortnight, and that at an hour (2h. 24m. a.m.) at which very few whom we address will care to be on the watch for the phenomenon. The Moon is in Taurus all day to-day, and until 2 o'clock to-morrow afternoon, when she will enter the northern part of Orion; which, however, she will quit for Gemini about 1 a.m. on the 17th. She is travelling through Gemini until 8 a.m. on the 18th, at which hour she crosses into Cancer. At 4 o'clock in the early morning of the

20th she enters Leo; passing across which constellation she descends into Sextans at 5 a.m. on the 21st, only, however, to quit it and re-enter Leo at 7 p.m. on the same day. At 8 o'clock the next evening she finally leaves Leo for Virgo, her passage across which occupies until 3 a.m. on the 26th. Then she enters Libra, where she continues until 4 a.m. on the 28th, crossing at that hour the boundary into the narrow northern strip of Scorpio. At 3 o'clock the same afternoon she enters Ophiuchus, and is on the confines of that constellation and Sagittarius when these notes terminate.

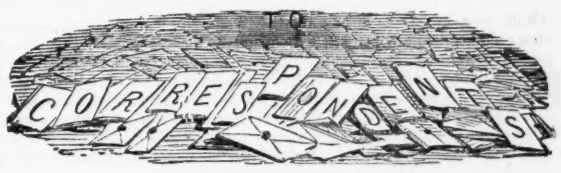
Miscellanea.

The Solar Heat.—Mr. Slack writes from Ashdown Forest that on Thursday, August 7, he placed a black bulb vacuum thermometer in an open box on a layer of cotton-wool, and with the bulb resting on black cotton velvet. Exposure to full sunshine between 11 and 1 o'clock caused the mercury to rise to 159° Fahr. The shade temperature a few yards off was 78° Fahr., and the difference between wet and dry bulbs of Mason's hygrometer 9° Fahr. The air was remarkably still.

The National Health Society's Vaccination Pamphlet.—We are pleased to find that this admirable circular, the facts of which have been approved of by the Local Government Board, is being distributed energetically in the metropolis. Some such antidote to the unscrupulous and pernicious literature of anti-vaccination was required, and we trust it will be eagerly accepted by the masses, who require their convictions to be strengthened. We especially note the cordial manner in which the Vaccination Officers' Association has received the circular, looking upon it as they do in the light of strong moral support to them in their duties. Apropos of this subject, we might mention several interesting clinical details which come to us from one of the metropolitan small-pox hospitals. Four children of an anti-vaccinator were attacked with small-pox, three of them being unvaccinated, and one vaccinated after repeated penalties. Two of the unvaccinated died, and the third narrowly escaped with his life, losing an eye in the struggle, whilst the vaccinated child had an exceedingly mild attack, and was out of bed in a very few days. Again, the family of an anti-vaccinator consisted of himself, wife, four children under ten years, and an infant. The wife and infant were the only vaccinated ones, the latter being vaccinated under compulsion, and these escaped small-pox, the other five being admitted to hospital and suffering severely. Lastly, the chairman of a local branch of the Anti-Vaccination Society was lately admitted to hospital and died.—*Medical Press and Circular.*

Scientific Philanthropy.—Mr. Lee J. Vance writes in the *Popular Science Monthly*: — "The conscious aim of scientific philanthropy is in the first place to deal with the struggle of man with nature—is to help men to help themselves; secondly, its aim is to regulate the struggle of man with man—is to help men to understand and adapt themselves to the conditions of existence. It is commonly noticed that the individual who succeeds in his struggle with nature is apt to be successful in the good-natured struggle with his fellow-men. As Darwin proves, the intemperate suffer from a high rate of mortality and the extremely profligate leave few offspring. There is economy in this process of elimination whereby the transmission of the industrial vices is restricted, and in the competition of life the degraded members of society, unable to adapt themselves to the conditions imposed by physical and social environment, succumb before the rest of the population. The scientific idea of benevolence involves, first, the preparation of man to receive intelligently nature's stern discipline—that is, to help him avoid all the evils coming from disobedience of physical agencies, and also to aid him in grasping those great rewards, which, as Huxley says, nature scatters with as lavish a hand as her penalties. The philanthropist will show us that the hereditary vices which the parent establishes for his children and his children's children meet in the long run with certain punishment. If we could believe in the certainty of punishment, says Sir J. Lubbock, temptation, which is at the root of crime, would be cut away, and mankind would become more innocent. The penalties attached to the consumptive, scrofulous, or syphilitic in contracting marriage are sharp and sure—oft-times swift and merciless. Men sin from a mistaken idea of what constitute's to-day's pleasure and to-morrow's pain, and it is not pleasant to be reminded that a great deal of our suffering is due more to ancestral errors than to our own."

The practice of taking tea with a principal meal, or what is called a "meat tea," is not to be commended. Tea does not promote digestion of the food in the stomach, and especially is not adapted to accompany meat, but rather bread and farinaceous articles. "Meat teas," as a daily habit, are more likely to create dyspepsia than not. The proper time for tea is an hour or two after food, or when the stomach is empty. Although a certain period of rest, after a hearty meal, assists the process of digestion, digestion is impeded by continuous sleep, which is pretty certainly made uneasy and disturbed when the stomach has been recently charged with a full meal. Quiet and refreshing sleep is best secured when the wants of the system have been satisfied by a meal in great measure digested, and when the functions of the stomach need no longer be in full activity, but a long fast and repletion are alike hindrances to sleep. Great caution is needed in sitting down to the chief meal of the day, when both mind and body are exhausted by long-continued labour and abstinence. A rapid, hurried mode of eating should be avoided, especially if the repast commences with some solid dish. There are advantages in commencing with some light food, such as soup, or fish, in small quantities, not calling for the full powers of the stomach, whilst the gastric juice is not in full flow, and when the muscular powers of the stomach partake of the general enfeeblement of the system. It is frequently supposed to be undesirable to commence with fluids, and this is probably the case if any large amount be taken, but not otherwise, in the case of a nutritive fluid like soup, by the gentle stimulus of which the secretions of the stomach are called forth. It is certainly preferable to the glass of sherry or prefatory dram.—*From "Food and its Use in Health."* By Sir Risden Bennett, in *Cassell's Book of Health.*



"Let Knowledge grow from more to more."—Alfred Tennyson.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the Editor of Knowledge; *all Business communications to the* Publishers, *at the Office, 74, Great Queen-street, W.C.* If this is not attended to delays arise for which the Editor is not responsible.

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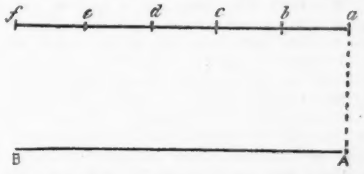
No communications are answered by post, even though stamped and directed envelope be enclosed.

FALSE PERSPECTIVE.

[1359]—I regret the appearance in your columns of the "flat cone" and the flourish about Zetetic Philosophy. My letter on certain errors to be found in most elementary books on perspective was not, I can assure you, intended to provoke this sort of thing.



Let *a, b, c, d,* &c., be a row of posts of equal height and equidistant from one another (ground plan), A, the position of an observer, A B being parallel to *a f*, then the post at *a* will appear taller than that at *b*, the one at *b* higher than that at *c*, and so on, and that at *f* will, of course, seem shortest of all, *simply because it is the most distant.* For this reason the imaginary straight line upon which the posts stand, and the straight line bounding their summits *cannot*, I contend, be *parallel.* Again, the spaces *a b, b c, c d,* &c., will grow shorter and shorter as they recede from the eye. The geometrical proof of this is very obvious.

T. E. Jones.

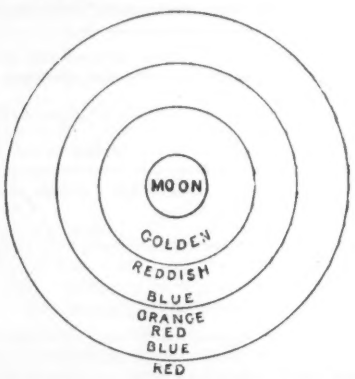
A COINCIDENCE.

[1360]—Last week I was going in for an examination in Scripture, and, opening my Bible at random, my eye caught the words, "Then are the children free." I was struck by the expression

and read it carefully over; the words haunted me, and, on receiving the printed paper of questions, the first words I again saw were, "Then are the children free." STUDENT.

LUNAR RAINBOW.

[1361]—The moon last night was quite a picture. When I left this room at a few minutes past 10 o'clock, I soon came into a street facing the moon; which, being near the full, its brightness naturally caused me to give it a look, when an exclamation of intense admiration escaped me—"Oh! look at the moon!" This was addressed to my wife, who replied, "I noticed it when I came out." (This was an hour before.) So that it had lasted thus long, then. As I did not know the bearings of the street (by compass) and the thought coming into my mind that Mr. Proctor (despite his churlishness relative to my ideas respecting the apparent *size* of the moon and sun at setting*) shall know of this splendid lunar rainbow—I turned to look for the polar star, and finding it (which looking informed me that at least 270° of heaven's canopy was clear of mistiness, while the 90° remaining, in the centre of which was the moon, was the contrary), I turned me round, and ascertained that the moon was near southing, was, in fact, as nearly as I could guess, about S.S. East. When we stood on the bridge crossing the "Foss" we had a long view of this "Picture," in the water and in the sky. Perhaps you have seen in your time, on the pulpits in churches, a representation of the sun, gilt—well, sir, the colour of the circle which immediately surrounded the moon, and which was nearly as broad as the disc of the moon itself, was a rich colour; while that of the moon was a lighter golden hue—this golden circle gradually finished in an *auroral* tinge; then was succeeded by another circle, nearly as broad, of a blue kind, such as I cannot describe, too lovely in fact—this ending in a faint orange-red, was succeeded by another circle of a fainter blue, which seemed to have a reddish rim as well; to use a simile, which is very unsimilar, the whole had an appearance like to a St. Katherine's wheel (fireworks) thus:



Not being able to leave it yet awhile, I distinctly noticed that the golden circle next the moon had a motion, of two kinds—slightly bulging out more on the west side than the east side, and the whole in motion from one side to the other, while this rim nearest, being brightest, showed the other motion best, viz.: it seemed to enlarge and contract just like the pupil of the eye acted upon less or more light. When I reached home, a few minutes past 11 o'clock, it was still in its beauty. When I retired to bed, after reading through the Birmingham Demonstration speeches, I moved the window-blind aside, and that part of the sky where the moon was situated was as clear as the rest had been, and there sailed the moon in her naked majesty, being divested of every particle of the late lovely lunar rainbow. I give it this name in ignorance of a better or more correct one. During the course of many years I have several times witnessed this phenomenon, of a larger but fainter kind; but never with the rainbow colours so distinct and so plain. WALTER FREDERIC CURTIS.

MIND AND BRAIN.

[1362]—In my brief remarks on the review you gave of Mr. Büchner's "Force and Matter" I had certainly not the slightest intention to prefer a charge of "obtuseness" against the writer, but wished simply to give my own personal opinion, *quod valeat*, in order to show that the idea, that thought is a mode of motion of the molecules of the brain, is "conceivable" to certain minds, without in any way setting up any dogmatic assertion that it "must" be so. The comparison of an organ cannot hold, since the brain, or rather the molecules of the brain, like every other organ of "living" organisms, is self-acting. An electric instrument would be a better comparison: apply the current, or produce the necessary surroundings, and it begins to act; such, I think, is the brain, apply the stimulus and the brain begins to act, producing "thought." Huschke puts it in this way:—"There subsists the same relation between the thought and the electrical vibrations of the filaments of the brain as between colour and the vibration of ether." Of course there are other "authorities" who maintain that the mind it an entity domiciled in the brain, playing on it like on an organ.—Yours truly, F. W. H.

[Huschke's illustration seems to me to fail in this respect. There can be no reasonable doubt that colour has its origin in the different wave-lengths and rates of vibration in the ether; but these do not become *colour* until they have been transmitted through the eye and optic nerve to the brain. Set up an electrical vibration of the filaments of the brain, and try to express hope, ratiocination, or will, in terms of such vibration. That it may be the efficient and indispensable means of their production, is a very very very different thing to the allegation that it *is* the feelings and affections themselves.—ED.]

* This is very courteous, soothing, and pleasing, and is probably designed to put the Editor into a good humour.

WHAT ALES IT?

[1363]—Bottled ale or beer *well-up* when poured into a tumbler gives more than enough of froth. A small piece of cheese in the glass checks *immediately* the froth.—Why? or How?—BOREAS.

LETTERS RECEIVED AND SHORT ANSWERS.

J. T. ROUTLEDGE. I have not read Professor Balfour Stewart's "Visible Universe," in the *Contemporary Review*, and am hence ignorant as to the nature of the arguments by which he sustains his allegations. If, as you seem to imply, he simply *asserts* that the waste—or seeming waste—of Energy in the Universe affords proof of the spiritual production of that Universe, than—be he "a person of authority in the scientific world" or not—he is talking nonsense. If we are going to admit the teleological argument at all into the discussion of any fact of nature, waste is evidence of absence of design and perfunctory workmanship; certainly not of prevision and adaptation of means to ends.—F. M. BILLINGS. Received. I have nothing to add to my former reply. Mr. Clissold regards Swedenborg as inspired. I am absolutely certain he was insane. We cannot argue on common ground.—BECCABUNGA kindly sends the address of the Cremation Society for the benefit of "Kemus" (p. 101). Communications should be addressed to W. Eassie, Esq., C.E., 11, Argyle-street, Regent-street, London, W. My correspondent goes on to complain of the non-appearance of articles on Evolution in KNOWLEDGE. I fancied myself that Mr. Grant Allen's interesting articles, one and all, illustrated different phases of Evolution, but I suppose that I (in common with many thousands of readers) was mistaken.—J. F. O. takes exception to a statement on p. 76 with reference to imprisonment for debt, and points out how the most thoroughly dishonest debtors can, and do, under the existing law, snap their fingers at their creditors. In fact, that, so far from the unfortunate debtor being treated as a criminal, the scoundrel almost systematically escapes.—H. SIGGERS. Everything depends upon the branch of astronomy to which you propose to devote yourself. Ball's is, in every respect, an excellent book.—MAJOR GASCOYNE. The sole official statement of the results obtained from the last Transit of Venus which has been so far issued, is that of the Belgian ones by M. Houzeau, in Tome V. of the "Annales de l'Observatoire Royal de Bruxelles" for 1884. I need scarcely say that no English results have been yet published. May I invite your attention to the concluding sentence (in capital letters) of those which head the Correspondence column.—H. P. S. Not easy to introduce into a *scientific* journal.—M. J. C., having apparently heard of Fontenelle's treatise for the first time through these columns, took it up at random from among a lot of old books recently found in a cupboard at a friend's house.—J. PAXMAN. You will see from p. 103 that Mr. Proctor had started for America at the date for which your invitation was issued.—WM. HARRISON. Received with thanks.—IGNORAMUS. 1. There are three primary colours, red, green, and violet. 2. A complementary colour is that which when mixed with the one to which it is complementary gives white light. Blue and yellow are complementary colours, so are red and greenish-blue, orange and what is called cyan-blue, and greenish-yellow and violet. The complementary colour to pure green is purple. Note especially that I am speaking of *light* of different colours, not of pigments. The blue and yellow of our paint-boxes, for example,

form green, and not white at all. 3. Flints are aggregations of silica round shells, sponges, echinites, &c., which died and sank to the bottom of the ocean which deposited the chalk. There were thermal springs then as now, and you know that hot water will dissolve more or less silica. 4. *Ciel et Terre* is published in Brussels on the 1st and 15th of each month in the pamphlet form. The subscription to it is 10 francs (*i.e.*, 8s. 4d.) a year, for which it is sent free by post.—PERCY GREG has seen a table move "without human or mechanical agency." Scores of people heard a musical-box play, and instantly cease playing, at the word of command, in the presence of a vagabond called Monck; the box standing absolutely isolated and in full view in the middle of a table without any cloth on it, and Monck's hands being held by the persons sitting on each side of him. When this highly respectable "medium" subsequently found himself in a police court, the *modus operandi* of this quasi-miraculous phenomenon was exposed at once. If we were to attribute everything for what we wholly fail to find an explanation to the action of "disembodied intelligences," then surely must we credit Bautier, Frikell, Hermann, and Maskelyne and Cooke with very intimate communion indeed with another world.—J. GREEVZ FISHER sends me a letter pointing out—in effect, albeit, in slightly more euphemistic terms—how very foolish I am not to reform my spelling straightway. He accompanies this by some little tracts which I will read. When I am convinced by them that "Nolij" is a better form of writing the title of this journal than KNOWLEDGE, I will consult the Messrs. Wyman as to the policy of substituting the first form of heading for the existing one.—H. WORMALD. A "singing mouse," poor little beast, has an inflammatory affection of its air passages.—G. A. SPOTTISWOODE. This journal addresses students of every branch of science, and the article to which you take exception was one possessing great *physiological* interest. KNOWLEDGE in no sense enters into competition with such publications as *Little Folks* or *Aunt Judy's Magazine*.—ALGERNON BRAY. Will you forward your address to the office of this paper, as a letter is lying here for you?—J. ELGIE. (1) How can you expect a body shining, ex hypothesi, only by reflected light, and never departing by many seconds of arc from its primary, to be visible with any power, high or low, at the stupendous distance of Algol? (2) D'Arrest, in 1865, found a 10–11th Mag. Star somewhere near the place in Cassiopeia. The new star blazed out in Nov., 1572, and this was afterwards seen by Espin in 1878. (3) You can divide Castor with a power of 80 on a 2-inch object-glass. (4) I cannot say offhand how many physically double stars are now known, but there are certainly some hundreds.

Our Mathematical Column.

EASY LESSONS IN CO-ORDINATE GEOMETRY.

BY RICHARD A. PROCTOR.

63. PROP.—*To determine the equation to a straight line parallel to a given straight line.*

Let the equation to the given straight line be

$$y = mx + c \qquad \text{(i)}$$

then since a straight line parallel to the given straight line must be inclined to the axis of x at the same angle, the equation required is

$$y = mx + c \qquad \text{(ii)}$$

an equation differing only in the constant term from equation (i).

It follows that the equation—

$$Ax + By + C = 0$$

represents a straight line parallel to the line whose equation is

$$Ax + By + C = 0$$

The equation to a straight line parallel to the straight line represented by the equation

$$\frac{x}{a} + \frac{y}{b} = 1$$

may be shown from the same consideration to be

$$\frac{x}{ra} + \frac{y}{rb} = 1$$

a relation which may readily be established independently; since it is obvious that the intercepts of two parallel lines on the axes of x and y must be respectively proportional.

64. PROP.—*To determine the co-ordinates of the point of intersection of two straight lines whose equations are given.*

Let the equation to the two given straight lines be

$$y = m_1x + c_1 \quad \text{(i)} \quad \text{and} \quad y = m_2x + c_2 \quad \text{(ii)}$$

Solving these simultaneous equations, we obtain

$$x = \frac{c_1 - c_2}{m_2 - m_1} \qquad y = \frac{c_1m_2 - c_2m_1}{m_2 - m_1}.$$

Since both equations are satisfied when we give to x and y the above values, it follows that the point which has these co-ordinates is a point on both lines,—that is, is the point in which the two lines intersect.

If $m_2 = m$, the values above obtained for x and y are indefinitely great. This is the analytical expression of the relation that parallel lines never meet.

If the equations of the lines be given in the form

$$A_1x + B_1y + C_1 = 0 \quad \text{(i)} \quad \text{and} \quad A_2x + B_2y + C_2 = 0 \quad \text{(ii)}$$

we obtain

$$x = \frac{B_1C_2 - B_2C_1}{A_1B_2 - A_2B_1}, \text{ and } y = \frac{A_1C_2 - A_2C_1}{A_2B_1 - A_1B_2}$$

65. PROP.—*To determine the condition that three straight lines whose equations are given may pass through a point.*

Let the equations of the three lines be

$$y = m_1x + c_1 \text{ (i)}, \quad y = m_2x + c_2 \text{ (ii)}, \text{ and } y = m_3x + c_3 \text{ (iii)}.$$

Then the x co-ordinate of the point of intersection of (i) and (ii) is $\frac{c_1 - c_2}{m_2 - m_1}$, and the x-co-ordinate of the point of intersection of (i) and (iii) is $\frac{c_1 - c_3}{m_3 - m_1}$. Hence, if (i) (ii) and (iii) meet at the same point we must clearly have

$$\frac{c_1 - c_2}{m_2 - m_1} = \frac{c_1 - c_3}{m_3 - m_1}$$

that is

$$c_1m_3 - c_3m_1 + c_3m_2 - c_2m_3 + c_2m_1 - c_1m_2 = 0 \qquad \text{(iv)}$$

In fact (iv) is the algebraical condition that the three equations (i) (ii) and (iii) may be equivalent to only two independent equations.

We know from algebra that if the three equations (i) (ii) (iii) are equivalent to only two independent equations, that is if condition (iv) hold, then when (i) (ii) and (iii) are multiplied respectively by the quantities $c_2m_3 - c_3m_2$, $c_3m_1 - c_1m_3$, and $c_1m_2 - c_2m_1$, and added together, both sides of the resulting equation vanish identically. Hence we obtain the following rule, which is frequently useful in practice. If three equations representing straight lines can be multiplied by such quantities that the sum of the resulting equations expresses identical equality, the straight lines represented by the three equations all pass through a single point.

66. PROP.—*To determine the form of the equation to a straight line passing through the intersection of two given straight lines.*

If these equations to the two straight lines are

$$A_1x + B_1y + C_1 = 0 \qquad \text{(i)}$$
$$A_2x + B_2y + C_2 = 0 \qquad \text{(ii)}$$

We may proceed to a full-length solution as follows:—

Solving (i) and (ii) we get for the point of intersection

$$x = \frac{B_1C_2 - B_2C_1}{A_1B_2 - A_2B_1} \text{ and } y = \frac{A_2C_1 - A_1C_2}{A_1B_2 - A_2B_1}$$

$\therefore$ by the equation to a straight line passing through the point of intersection of (i) and (ii) is of the form

$$A\left[x - \frac{A_2C_1 - A_1C_2}{A_1B_2 - A_2B_1}\right] + B\left[y - \frac{B_1C_2 - B_2C_1}{A_1B_2 - A_2B_1}\right] = 0 \qquad \text{(iii)}$$

$$\text{or } (A_1B_2 - A_2B_1)(Ax + By) + (B\,B_2 - A\,A_2)C_1 + (A\,A_1 - B\,B_1)C_2 = 0 \qquad \text{(iv)}$$

Now if we multiply (i) by $(B\,B_2 - A\,A_2)$ and (ii) by $(A\,A_1 - B\,B_1)$ and add, we get for the co-efficient of x

$$A_1B\,B_2 - A\,A_1A_2 + A\,A_1A_2 - A_2B\,B_1 = B(A_1B_2 - A_2B_1)$$

and for the co-efficient of y

$$B\,B_1B_2 - A\,A_2B_1 + A\,A_1B_2 - B\,B_1B_2 = A(A_1B_2 - A_2B_1)$$

or for the resulting equation the form (iv).

We might simply have proceeded thus

$$A_1x + B_1y + C_1 = 0 \qquad (1)$$
$$A_2x + B_2y + C_2 = 0 \qquad (2)$$

any equation of the form

$$l(A_1x + B_1y + C_1) + m(A_2x + B_2y + C_2) = 0 \qquad (3)$$

which is also obvious since whatever values of x and y satisfy (1) and (2) must also satisfy (3). It is also obvious that *every* equation to a line passing through the intersection of (1) and (2) can be put in the form 3, seeing that the ratio B : A of the preceding article is the tangent of the angle made by a straight line through (i) (ii) with the axis of x, and as we have seen to give B and A suitable values, all we require is that the following equations shall hold.

$$l = B\,B_2 - A\,A_2$$
$$\text{and} \qquad m = A\,A_1 - B\,B_1$$

The method of the preceding article leads directly to the very valuable method of treating certain problems on the straight line called the Method of Abridged Notation. I do not here dwell upon it because any one who is likely to require much information on the subject would go to treatises where the methods of co-ordinate geometry are more fully dealt with than they can be here.

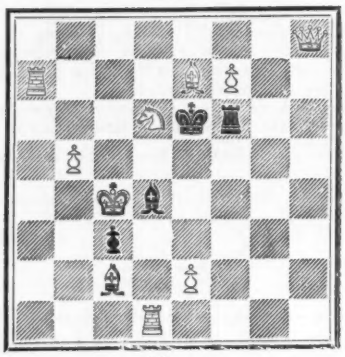
Our Chess Column.

By Mephisto.

PROBLEM, No. 123.

(Selected.)

Black.



White.

White to play and mate in two moves.

SOLUTIONS.

Problem No. 120, p. 102.

1. Q to Kt5	1. B to K5
2. Q to B sq. mate	
	1. P to Kt7
2. Q to B5 mate.	

No. 121.

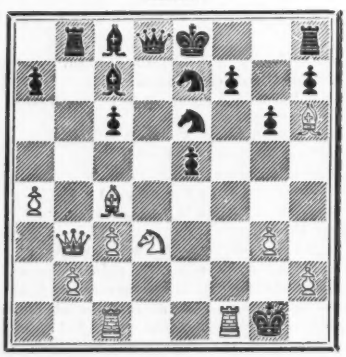
1. Q to Q3 and mate accordingly.

Ending p. 102.

1. R to K8 (ch)	1. R × R
2. Q to Kt8 (ch)	2. K × Q
3. P × R mate	
	If 2. K to K2
3. P × R (Q) (ch) and wins	

ENDING FROM ACTUAL PLAY.

Black.



White.

1. B × Kt	1. R × Q
2. B × P (ch)	2. K to Q2
3. Kt to B5 (ch)	3. K to Q3
4. R to B6 (ch)	4. K × Kt
5. B to Q3 (ch)	5. Q to Q5
6. P × Q (ch)	6. K to Kt5
7. B to Q2 (ch)	7. K × P
8. R to R sq. (ch)	8. K to Kt4
9. B × R and White won	

GAME AT ODDS OF TWO KNIGHTS.

We publish the following amusing game as a curious example of of odds giving.

Remove the two White Knights.

1. P to K4	P to K4
2. P to Q4	P × P
3. B to B4	B to B4
4. P to QB3	P × P
5. Castles	P × P
6. B × P	Kt to KB3
7. P to K5	P to Q4

This move is often played, but not when the B is on Kt2; of course, receiving the odds, Black ventured something to exchange pieces.

8. P × Kt	P × B
9. R to K sq. (ch)	B to K3
10. P × P	R to Kt sq.
11. Q to R5	

White threatens R × B, also Q × B and Q × RP; the latter move especially would be dangerous.

B × P (ch)

Black was bound to lose a piece. K to Q2 would have been best, but B × P looked feasible.

12. K × B	Q to Q7 (ch)
13. K to Kt sq.	

An artful move

Q × B

Besides this likely-looking move, Black could have played K to K2, but White would maintain his attack.

14. R × B (ch)	K to Q sq.
15. R to Q sq. (ch)	K to B sq.

If Kt to Q2 then R × Kt (ch), and mates in four moves.

16. R to K8 (ch)	R × R
17. Q to B5 (ch)	R to K3
18. P to Kt8(R) (ch) and mate.	

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

Joseph Farrar.—In the article on the Roy Lopez in Knowledge, p. 490, Black's move ought to read 9. Kt to K3.

G. Thompson, T. B. S., Chas. T. Wilbraham, M. T. Hooton, C. T. G.—In Problem No. 122, if 1. Q to K2, B to B3, and there is no mate.

Correct solutions received.—Problem p. 80, H. A. N.; No. 120, 121, A. W. Overton, M. T. Hooton, G. Thompson.

Contents of No. 145.

	Page
The Morality of Happiness. By Thomas Foster	103
The Sea Horizon. By R. A. Proctor	104
The Sense of Taste. By Grant Allen	105
The Origin of Silk	106
Dreams. VI. By Edward Clodd	107
The Earth's Shape and Motions: Introduction. By R. A. Proctor	108
The Electro-Magnet. By W. Slingo.	109
The Capture Theory of Comets. By R. A. Proctor	111
Mind in Man and Brute. By G. J. Romanes	112
Natural Gas Fuel at Pittsburg	113
The Tarantula of Southern California. (*Illus.*)	114
Attitudes after Death. (*Illus.*) By C. E. Brown-Séquard	115
Other Worlds than Ours. By M. de Fontenelle. With Notes by Richard A. Proctor	117
The International Health Exhibition. XI. (*Illus.*)	118
Editorial Gossip	121
Our Paradox Column	121
Correspondence	122
Our Mathematical Column	123
Our Chess Column	124

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